The Social Shaping of ICTs Standards

: A Case of National Coded Character Set Standards Controversy in Korea

Jinsang Hwang

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For Hayeon

Declaration

I declare that this thesis is my own work throughout, and the thesis has not been submitted for any other degree or professional qualification.

Jinsang Hwang

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Abstract

This thesis examines the historical array of 'social' and 'technical' factors that have shaped the development and evolution of Korean national Coded Character Set (CCS) standards. CCS standards refer to a layer of compatibility standards which specify rules for digital representation of textual data at the most basic level of Information and Communication Technologies (ICTs). The effective and efficient operation of information processing, storage, and exchange is thus dependent on the employment of technically sound, economically viable, and culturally adequate CCS standards at national, regional and international levels.

Historically, the CCS standards had emerged around the cultural presumptions and practices of the US and Western Europe due to the economic and technical dominance of the region from the formative stage of ICTs development. As the need for global information infrastructure and multilingual information processing has been growing, however, the international CCS standards regime has evolved (from ISO 646, to ISO 2022, and ISO/IEC 10646-1) to incorporate various national scripts around the world, and the issues have arisen over the adequate representation of these scripts within the international standards regime. For example, the incorporation of East Asian scripts, such as Chinese, Japanese, and Korean, presents a formidable challenge with their exceptionally large repertoire.

In particular, the design and implementation of Korean national CCS standards, normally a exclusive domain of experts and bureaucrats, had caused a series of heated public controversies during the 1980s and 1990s. Despite the intensity of disputes and the breadth of participation in the controversies on Korean national CCS standards, the standardisation process had not been subject to a detailed socio-economic analysis, the lack of which allowed deterministic and simplistic speculations to appear, implying technological rationality, economic imperatives or corporate strategies alone have guided the CCS standards along a linear development path with increasingly larger and more powerful standards replacing previous ones.

Drawing on the social shaping of technology perspective, the case study examines the evolution of Korean national CCS standards, focusing both on the process in which a standards emerges as a result of network building activities and alliances formation of various actors, and on the changes in immediate and broader contexts around the standardisation which directly and indirectly affect the interests alliances and evolution of standards. Contrary to the deterministic and simplistic perspectives, the case study suggests a structured but also dynamic social shaping process of the Korean national CCS standards. Four major themes forwarded in the case study are as below:

First, the case identified a received view on the Korean controversy which can be characterised as 'technological fix on cultural problem' in a sense that technical challenge experienced in Korean character encoding was a product of distinctive local culture and the problem was fixed by the steady advances in the information technology. Without denying the importance of the state of technological capabilities, however, the case shows that social choices had been made both in international and national standards and had critical roles in shaping various controversy and whole national standards setting process.

Second, the case study identifies two contrasting modes of standardisation, 'technicisation' and 'politicisation,' and examines how the fluctuation between them has affected the development of Korean national standards setting process. In the discourse of technicised standardisation, technological knowledge is accepted as neutral, asocial 'hard fact.' Accordingly, the social choices are obscured and the standardisation process is to be dominated by the negotiation among disinterested experts over the relative technical merits of standards. Under the politicised mode of standardisation,' the political nature of CCS standards design - conflicting values and incongruent ascription of technological properties as a result - is brought forward. The standardisation is characterised by the formation of and competition among interests alliances. The outcome of standardisation seems to be dependent on which mode is dominant as well as who prevails in each mode.

Third, the case study raises a question about the relationship between the standards and interests embedded in them. The ascription of certain technological properties to standards and the interests alliances built around them proved unstable and dynamic. Both of them seem to be influenced by network building activities of actors and their backdrop, a specific configuration of economic, social, cultural, political and technological factors, enabling and constraining the activities of actors involved in the standardisation process. As the makeup of the configuration changes for various reasons, - for example, globalised software market, social movements, surge of nationalism, political democratisation, advances in related technological field - the meanings attached by the actors to the standard also shifts, and the interests alliances based on them are unmade and replaced by new ones, producing a series of character set standards.

Fourth, the study also draws attention to the complexity involved in the national standardisation process and the challenge faced by the social research into those intricate social shaping process. The standardisation process involved many actors at different levels and across various geographical locales. Also there had been recurrent but unpredictable changes in the relationship among the actors and between the actors and artefacts. A recent trend in the social shaping approach - a call for a decentralised concept of actor and the transforming terrain of innovation - was found helpful to meet the challenge. In particular, the concept of 'development arena' was found useful to meet the challenge and to understand the case in balance between the actions of different 'modes of performance' and the contexts of varying 'configurations' of heterogeneous elements.

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CHAPTER 1

Introduction

As technology has long been one of the most distinctive and important features of humanity, it is not surprising that the mastery of certain technologies has often been associated with a developmental stage or with the overall nature of the society concerned, such as the 'Iron age', 'industrial society', and the 'information society'. The relation between technology and society has, therefore, become a subject of intense speculation in literature, business, politics, and the social sciences. In particular, a common but misleading perspective on the issue, 'technological determinism', has had a strong grip on the public imagination, business, the policy agenda, and academia. Technological determinism argues that technology, either applying scientific research or being guided by its own logic of development, causes major social changes or constitutes the most important factor for such changes. Thus, it makes two closely related claims, that 'particular paths of technological change were both inevitable and required particular kinds of "social" change' (Williams 1997, p.300), in other words, technological change is perceived to be 'autonomous' and independent of society in some sense, and seen to cause 'social change' (MacKenzie & Wajcman 1985, pp.4-5).

The 'social shaping' approach to technology is one of the potent critiques of technological determinism. Drawing on a variety of traditions, such as industrial sociology, evolutionary economics, economic history, sociology of science and scientific knowledge, history of technology, innovation studies, and policy studies,[1] the social shaping of technology forms an interdisciplinary research tradition, sharing some main features which differentiate it from other perspectives on the technology-society relationship. First, it examines the contents of technology and the particular process involved in innovation, compared to the conventional practice of 'black-boxing' technology and focusing on its effects on society. It attempts to reveal 'socio-economic patterns embedded in both the contents of technology and the processes of innovation' (Williams & Edge 1996, p.866). Second, it highlights the intrinsic uncertainty and unpredictability of technological changes in contrast to the notion of an 'inevitable' path of technological change. Attention to contingencies and heterogeneity replaces various reductionist explanations. Third, it emphasises the complex processes around any technological change, paying attention to organisational, political, economic and cultural factors as well as narrowly defined technical ones. Refuting deterministic visions of the society-technology relationship, the social shaping research tradition has accumulated empirical case studies from various fields of technology,[2] and reveals a very complex picture of the mutual shaping process of technology and society.

While social research on technology was becoming an established research tradition, advances in information and communication technologies (ICTs) led to an ascendancy of technological determinism. The unprecedented pace of development in microelectronics, digital computers, and communication technologies, and their successful integration into ICT systems, have convinced many observers of the visions of radical social transformations, such as 'information society', 'globalisation', and 'network revolution'. Much attention is being given to the current or future impacts of ICTs with strong deterministic connotations. In

[1]For the intellectual origins of the social shaping perspective, see Williams & Edge (1996) The social shaping of technology, and MacKenzie & Wajcman (1985) The social shaping of technology: How the refrigerator got its hum.

[2]For early collections of case studies, See Bijker, Hughes & Pinch (1987) The Social construction of technological systems: New directions in the sociology and history of technology, Elliott (1988) Technology and social process, MacKenzie & Wajcman (1985) The social shaping of technology.

white papers of national governments or international bodies, company strategies, and academic discourse, ICTs are commonly portrayed as a panacea for organisational, economic, or social problems, and the single most important driving force behind the trend towards a new form of society, while the development of the ICTs itself is seen as a consequence of natural progress.[3] However, the deterministic portrayal of the nature and impact of ICTs has also been subjected to critical assessment.[4] For example, the alleged contribution of ICTs to productivity gain became a source of debate over the so-called 'productivity paradox' (Freeman 1988), and the ICTs were also argued to be a means of reinforcing the status quo as much as an instrument of a radical change (Schiller 1981). The social shaping approach also turned its attention to ICTs and has engaged in empirical research and theoretical discussion over various issues in ICTs, revealing complex and uncertain processes in the ICTs' development and adoption.[5]

1.1 Research on Coded character set Standards

One of the focal points of this rich body of research and of particular interest here is interoperability as an essential feature of ICT systems and compatibility standards as a main instrument to achieve it. Distinctive features of ICTs such as 'increasing returns to adoption,' strong 'positive network externality,' and the risks and uncertainties involved in high investment and emerging markets all point to the benefit of standardisation in ICTs. Related to these economic factors is the historical development of ICTs, that is, fragmentation and specialisation into layers of components of ICT systems, which has led to the strategy of

[3]Two frequently quoted White Papers from the European Commission are Bangemann Group (1994) Europe and the global information society: Recommendations to the European Council, and European Commission (1994) Growth, competitiveness, employment: The challenges and ways forward into the 21st century.

[4]For a good guide to the social research on ICTs, See Dutton (1996) Information and communication technologies: Vision and realities, a collection of selected articles from the ESRC funded Programme on Information and Communication Technologies (PICT).

[5]For a general overview of the social shaping of ICTs, See Williams (1997) The social shaping of information and communications technologies and Williams & Edge (1996) The social shaping of technology.

'configurational' technology, building a system by assemblage of standardised 'black-boxes,' and customised solutions to cater for diverse user requirements without full customisation. Essential for this development is the stabilisation of interfaces between components at both hardware and software levels. The compatibility standard is a class of standards that define interfaces, offering a way of achieving interoperability within a system, between networked systems, and between complementary goods (Grindley 1995, p.9).

Computer-based ICT systems are particularly dependent on compatibility standards, for the systems usually consist of a complex array of components and sub-systems or a network of several systems. Therefore, the interconnections at various layers between constituent parts are essential for the functioning of the system, and compatibility standards offer solutions for the matching problem.[6] One such case is the coded character set standard. A coded character set is a set of rules that specifies the selection of textual data elements and their relation with corresponding electronic signals used internally in computers.[7] While a coded-character set could be designed to cater for the special needs of the individual computer or individual user, there is no doubt that a standardised coded-character set would greatly facilitate process, storage and exchange of textual data within a community using the standard. The development efforts for coded character set standards made by national, regional and international standards bodies attest the point.

Interestingly though, despite the crucial function it performs in the handling of digitalised textual information, the coded character set standards had not attracted much attention from the public or researchers in the field of ICTs and ICT standards, apart from the exceptional case of the Korean national character set being presented here. The dearth of interest can be attributed to two main reasons. First, within the countries where the development and the use

[6] OSI (Open Systems Interconnection) reference model is an example of an attempt to address the problem of interconnection in a systematic way by standardising eight layers of interconnections.

[7] For formal definition and detailed explanation, see Section 4.1.

of computers were mostly concentrated at an early stage, such as the U.S. and Western Europe, the coded character set standards had remained virtually invisible to the user. Because computer architectures were designed to be compatible[8] from the beginning with the demands of national scripts, most of which were based on the Latin alphabet, national coded character set standards could emerge from the early stage of computer development without much difficulty. Second, when computer technology was diffused to other regions with radically different cultural demands for character sets, the conflicts between the imported computer architectures could have raised questions about the distinctive social character of standards design. However, the overall development of character-encoding schemes has been, in most cases, seen to reflect a linear and natural progress in computer technology in terms of gradual enlargement of codespace,[9] and therefore the character-set standards issues were predominantly seen as a simple problem of time-lag between the higher cultural demands of particular regions and the contemporary state of technology.

Against this tendency, however, the national standardisation of technological specifications became a source of disputes among experts and later an issue of public controversy in South Korea[10] from the early 1980s to the late 1990s. Compared to the early success of the U.S. national coded character set standard, ASCII, in the 1950s, the first successful establishment of a Korean national standard came as late as 1987 with KSC 5601:1987 after the two abortive attempts of KSC 5601:1974 and KSC 5601:1982. Although the KSC 5601:1987 no doubt contributed to the standardisation of chaotic Korean character encoding practices, it

[8]The unit of memory, register, and communication channel was constructed around the unit of byte (8-bit) that could accommodate most of the demands of Latin-based scripts.

[9]Codespace is the total number of numeric values assignable to characters by given coded character set.

[10]The less official but more common name of 'South Korea' is used throughout the thesis to refer to the Republic of Korea (ROK). The Democratic People's Republic of Korea (DPRK), also known as North Korea, has separate national character-set standards, and there was no comparable standardisation issue in the North Korea.

soon became a focus of disputes. Soon after the standardisation, the expert community in the field became divided into two opposing camps, one supporting the new national standard and the other a rival market standard, each of which was based on one of two major encoding approaches to Korean script, Wansung and Johap respectively.[11] Then, disputes among experts over the relative merits of the competing standards escalated into a controversy with intensive public campaigns by the two competing alliances in the period 1991-1992. The controversy seemed to subside as legislation in 1992 conferred national standard status on both competing standards. However, the coded character set standard issue re-emerged in 1995 when Microsoft Korea tried to incorporate a new proprietary coded-character set in its Windows 95 system software, anticipating a conversion of the international standards regime from ISO 2022 into Unicode. Then, in 1998, Microsoft's move to eliminate a rival word-processor application, 'Hangul' (or HWP),[12] provoked intense public protests and controversy, the result of which had great implications for the national coded character set issue, for HWP was the only viable word-processor application in the market using the Johap standard as its basic character set. HWP and, as a result, Johap survived the crisis in 1998 due to the unprecedented public intervention. However, Johap was to be abandoned in 2000, as Haansoft, developer of HWP, decided to shift its basic character set from Johap to Unicode, effectively ending the competition between the two different types of coded character set standards and closing the controversies around it.

[11] Wansung and Johap roughly means 'precomposed' and 'conjoining' respectively. More details are in section 5.3.2. See for more, Lunde (1999) CJKV information processing.

[12] 'Hangul', the name given to the application by its developer, uses an old Korean vowel letter that ceased to be used after Modern Korean grammar was established in 1933. Because the vowel sound itself was lost except in a southern island dialect and tends to be pronounced incorrectly, the name of the application sounds the same as the name of the Korean script itself, 'Hangul'. The use of 'Hangul' for both could cause confusion, so a commonly used English name 'HWP' is used throughout the thesis. The initials HWP derived from the words 'Hangul Word-Processor' that is also used for the file extension of the text format created by the application.

1.2 Research Questions

The Korean national coded character set standardisation provides a unique research opportunity into a technological standards setting process. A series of technological disputes and their escalation into public controversies help to reveal locations where social choices are made over the contents of technological artefacts. The unusually broad participation of multiple actors from various geographic locales and at various levels, and the interaction between them, also help to examine the complex relation between different values and priorities carried into the technological standard setting. Also, the two decade long competition allows the research to trace the shifting alliances of interested parties as social, political, cultural, economic, and technological circumstances change over time.

The aims of the research are: to examine the development of the Korean national standard set standards in conjunction with the changes of international standards regime and other environmental parameters around the standards; and to develop a non-deterministic, anti-essentialist, dynamic model of the social shaping process of technological standards. Major lines of enquiry were set out as the research questions below:

- To what extent can the development of Korean and international coded character set standards be explained in terms of technological advances and social choices?
- What were the circumstances leading to the successful technicisation and also to the politicisation of the standardisation process in the Korean national coded character set standards controversy?
- What were the main factors behind the recurrent stabilisation and destabilisation of the standards and the interests allied behind them?
- What was the nature of the relationship between local and global constituents of the coded character set standard setting, and how has it changed through the period of the Korean controversy?

The first research question concerns the technological determinism found among participants and observers of the Korean coded character set standards development. The whole standardisation issue was commonly seen as a 'technological fix on a cultural problem,' for the initial constraints and subsequent improvements in the international standards were crucial factors for the local controversy, and the changes were largely attributed to the advancement of microelectronics. The case study looks into the contents of the international and Korean coded character set standards, and identifies major social choices made in the design features. The subject of the second question is the circumstances of a rare occasion of public controversy on technological standards. The case study found two dominant logics of standardisation in 'technicisation' and 'politicisation', and shows the process where a technicised discourse of Korean coded character set standards was successfully politicised. The third question follows the development of the second. With the politicisation of the standard setting process, the relationship between interests and artefacts became more visible. The case shows that an instance of the alignment of interests and subsequent stabilisation into a standard is likely to change over time as the significant environmental parameters change. The subject matter of the fourth question is the decentralised concept of the actors in the changing configurations of standardisation arena. Even though the controversy has been largely a local dispute, the Korean national coded character set standard has been shaped by the interactions of a variety of actors at various levels and in different locales. The leadership of the standardisation process has been taken up by various actors in a series of differently configured arenas with shifting boundaries and unpredictable outcomes.

1.3 Structure of the Thesis

The thesis consists of ten chapters including the introduction. Chapter 2 introduces the social shaping of technology (SST) as a major theoretical approach of the research. Section 2.1 explains the formation of the approach and some current developments relevant to the research. Then section 2.2 moves to the field of information and communication technologies (ICTs) around which some of the major discourses of social transformation have been built. A rich body of research conducted under the social shaping approach, however, reveals the intrinsically social nature of the ICTs. Section 2.3 focuses on compatibility standards, a key solution for much- needed interoperability of ICTs. The significance of compatibility standards in contemporary ICTs was shown with the different research approaches to the phenomenon.

Chapter three describes and justifies the methodological approach and methods chosen for the research reported here on Korean national coded character set standardisation. First, section 3.1 examines the case study research design in general, and a typical version adopted in many social shaping approaches as well as here. Case study design is identified as a type of research design among elements of social research, and two potential sources of problems with the case study design are discussed: the time scale and quality criteria of social research. Section 3.2 describes the case study design of the Korean coded character set standardisation, and the methods of data collection used in the research.

Chapter 4 provides background knowledge about coded character sets and the main features of three generations of the international coded character set standards regime. First, section 4.1 introduces a definition of character set and the main structural features of the character set, that is, the relations between bit size, codespace, and costs. It is followed by three sections, each explaining one of three generations of international standards regimes, ASCII, ISO-2022, and ISO10646-1. Section 4.2 covers ASCII, one of the earliest and most successful coded character set standards of all, and its internationalisation, ISO-646. Section 4.3 explains the ISO-2022 extension techniques, the second generation of the international standards regime, which had a crucial influence on the development of various East-Asian national coded character set standards. Section 4.4 then explains the most recent developments in international standards, ISO/IEC 10646-1 and Unicode, which laid the foundation for truly multilingual information processing and exchange for the first time.

Chapter 5 then introduces a Korean indigenous script, 'Hangul', and summarises local efforts to incorporate the Korean script into the world of computerised information processing. Section 5.1 gives a general introduction of 'Hangul' and its distinctive writing system, a system of phonetic alphabet and syllabic glyphs. Section 5.2 reviews a series of solutions designed to enable Korean input/output in ASCII-based personal computer architecture. Different layers of personal computer architecture were targeted by various solutions at the level of input/output hardware, system software, and applications software. Section 5.3 introduces three generations of Korean character sets; byte-oriented first-generation Korean character sets for mainframes and 8-bit personal computers; two rival double-byte character sets of the second generation; and the third generation of 16-bit character sets based on UCS and Unicode.

Chapter 6 covers the period from 1985 to 1992 of the Korean controversy, roughly the first half of the whole controversy. Section 6.1 summarises two unsuccessful attempts by government to standardise the Korean character set. Section 6.2 covers the establishment of the first successful national Korean coded character set standard, KSC 5601:1987, after close competition between two proposals based on Wansung and Johap. Section 6.3 describes the subsequent developments of the situation after KSC 5601:1987 was enacted. Criticism of the new standard by experts outside of government institutions began to appear, and the technological properties of the competing character sets were contested by groups of experts. The criticism gathered pace with the amendment plan announced in 1990, but the demand for a radical change was overruled by the government, and the main architecture of KSC 5601:1987 was maintained in the first amendment, KSC 5657:1991. Section 6.4 follows the intensification and diffusion of the standards controversy through more organised and co-ordinated campaigns with ever-increasing involvement of civic groups and the public in general. The public controversy led to the introduction of a more broad-based standards policy and the inclusion of Johap in the second amendment of the national standard in 1992.

Chapter 7 describes the transformation of the international standards regime, that is, the rapid progress made in the UCS (Universal Character Set) project and Unicode, and equally important changes made in the Korean coded character set standard-setting process. Being the first multilingual international character set without a cumbersome shifting mechanism, the emergence of ISO/IEC 10646-1 and Unicode has great implications for multilingual data processing and the internationalisation of software. And also it has special relevance for the Korean national coded character set standard controversy, for the whole controversy was set against the backdrop of the limitations imposed by the ISO 2022 rules. Section 7.1 summarises the short history of ISO/IEC 10646 and Unicode, two separate efforts by ISO/IEC JTC1 and the Unicode consortium to build a more powerful and stable multilingual coded character set standard, and the merger of the two. Three following sections describe the development of the Korean controversy in conjunction with the changes in international standards. Section 7.2 shows the early involvement of the Korean government in the formation of a Korean repertoire and Chinese ideography in DIS 10646, its influence on the design and the controversy around the KSC 5657:1991. Section 7.3 describes a significant change made in the Korean government's standards policy towards a broad-based and active participation in national and international standard setting. The newly established expert committee assumed a crucial role in shaping the new Korean repertoire during the structural changes in the DIS-2 10646. Section 7.4 follows the process in which further repertoire changes were made in the 10646-1 and Unicode in 1995 through the co-operation and alliances among former adversaries in the Korean market.

Chapter 8 covers the second phase of the Korean controversy, the market competition between two national coded character set standards, Johap and Wansung, after the 1992 ruling for dual standards, and two occasions of character-set related controversy in 1995 and 1998, and final closure of the controversy in 2000. The topic of section 8.1 is the continuing competition of the two national standard in the market in the form of a rivalry between two major word-processor applications in Korean market, Microsoft 'Word' and Haansoft's 'HWP', which represents in a sense a proxy war between the character sets. The grounds of competition moved from the standards bureau and the advisory committee to the software market, where various products incorporated one or other of the coded character set standards with important implications for the main features of the product. Section 8.2 introduces the eruption of a more public and antagonistic controversy over the coded character set issue in 1995, when the Microsoft Korea opted for its own proprietary coded character set, called 'Extended Wansung,' for the new operating system, Windows 95 Korean version. The move by Microsoft frustrated and angered many Johap supporters, thus reviving the public controversy over the Korean coded character set standardisation. Section 8.3 deals with the Microsoft's attempt to force out the rival word-processor, 'HWP', through a negotiation with the financially ruined developer of the application. This caused an unprecedented public outcry and extraordinary nation-wide mobilisation to keep the application and thus Johap alive. Section 8.4 describes what followed the explosive event, a slow sea-change of the coded character set standard in the Korean applications market, in the direction of Unicode. Despites the public support for Johap shown in 1998, Johap was finally abandoned by Haansoft Inc., the developer of HWP, in favour of Unicode. The 15 years of the coded character set standard controversy came to a close.

Chapter 9 reviews four main analytical themes of the research set out by research questions with findings of the research. Section 9.1 identifies a common but misleading perspective on character-set standards development as a 'technological fix on a cultural problem,' and refutes it by pointing out crucial social choices made in the design of Korean and international character-set standards.

Section 9.2 seeks to explain how the normally arcane world of technological standards became a subject of public controversy in relation to the two competing logics of standardisation; technicisation and politicisation. The subject of section 9.3 is the transformation of interest alliances, through which the actors' identification of interests vis-à-vis a given artefact has been changing according to the circumstances, and this has shaped a series of shifting interest alignments. Section 9.4 addresses two distinctive features of the Korean character set standardisation process, the involvement of multiple actors at various levels in different locales, and their changing relationship between them over time during the standardisation process, and uses the concept of 'development arena' as a decentralised concept of actors in a transforming terrain.

Chapter 10 is the concluding chapter of thesis. Section 10.1 revisits and answers the four research questions set out in the introduction. Section 10.2 assesses the overall implications of the case study to the social studies of technology.

CHAPTER 2

Literature review

The research conducted here into the Korean national character-set standards is largely informed by the research tradition of social shaping of technology (SST). For decades, the social shaping approach has developed a number of valuable conceptual tools and analytical models, which help to improve our understanding of the complex relationship between society and technology. Moreover, researchers in the social shaping approach have conducted numerous empirical researches in various sites of information and communication technologies (ICTs), correcting widespread deterministic and simplistic accounts of the development of ICTs and their impacts on society. The accumulated theoretical resources and empirical researches on technological change in general, and ICTs and compatibility standards in particular, guided this research into the Korean national character-set standardisation process. The main objective of this chapter is to review the social shaping approach both in terms of theoretical resources and substantive findings from the field of ICTs and the standardisation process, locating the research on character-set standardisation within the tradition of social shaping of technology.

The chapter consists of four sections. Section 2.1 introduces the social shaping of technology (SST) as a major theoretical approach of the research with brief summaries of the formation of SST and some current themes of developments. Section 2.2 follows major discourses of social transformation based on particular views of ICTs, and the critiques from the social shaping approach. Section

2.3 turns to the significance of 'compatibility standards' in contemporary ICT systems and various theoretical approaches to the phenomenon. Section 2.4 concludes the chapter.

2.1 Social Shaping of Technology

As briefly mentioned in the previous chapter, the social shaping approach is not a singular and well-defined school with standardised research procedures and analytical approach, but a loosely defined tradition within the research community, whose members came from several academic disciplines and shared their concerns on the development of technoscience and its relationship with society. However, despite the heterogeneous nature of the approach and the internal tensions on some theoretical and methodological issues, the social shaping philosophy has developed a distinctive approach to research on technological development. First, it moves the focus of research efforts from the impacts of technology on society to the contents of that technology, that is, the process which shapes the technology itself. It is argued that the contents of technology and its shaping process should be amenable to social research, as opposed to the conventional treatment of technology as a 'black-box' or exogenous variable. Second, it highlights social choices made in the design and implementation process of the technology in question. The social shaping approach suggests that technological development is not determined by inner technical logic or any other single overriding imperative, but shaped by a mixture of social, cultural, organisational, and political forces. Therefore, the term 'social shaping of technology' is given to a broadly defined research approach which focuses on the content of technology and the critique of simplistic and deterministic perspectives (MacKenzie & Wajcman 1985, Pinch & Bijker 1984, Russell & Williams 2002, Williams & Edge 1996). The rest of section 2.1 summarises the formation and development of the social shaping approach in terms of its main intellectual origins and early schools formed during the 1980s, and the main lines of developments of the field relevant for the thesis.

As an interdisciplinary research framework, the emergence of the social shaping approach is indebted to various research traditions for theoretical and empirical works such as the sociology of scientific knowledge, industrial sociology, technology policy studies, and the economics of technology. First, an emerging field of sociology of scientific knowledge (SSK) in the 1970s made crucial contributions to the formation of the social shaping approach. While the conventional sociology of science of the time concentrated on science as an institution, a new breed of researchers mainly from several U.K. centres pioneered a new approach that extends the sociology of knowledge into the field of hard science. Drawing on mainly historical case studies, proponents argued that the contents of scientific knowledge are socially constructed. Causal connections between macro-social variables like 'interests' and the contents of scientific knowledge have been made, and also micro-social 'negotiations' were uncovered in the production of scientific fact during controversies (Pickering 1992, pp.1-4). Thus, the SSK strongly influenced the social shaping approach on technology, leading to the 'technological turn' in the 1980s.[1] First, the research programme of SSK, formalised in Collins' 'Empirical Programme of Relativism (EPOR)', has a direct bearing on the foundation of its equivalent research programme for technological artefacts, 'Social Construction of Technology (SCOT)'. Second, SSK and the 'Strong Programme' in particular, has significant influence on the treatment of 'technological knowledge', for the successful investigation of the social origin of credibility of scientific knowledge helps to overcome the misleading image of technological knowledge as 'hard facts' and to avoid artificial and unhelpful distinctions between the 'technical' and 'social' in social research into technology (MacKenzie 1990, pp.8-12).

[1]See, Woolgar (1991) The turn to technology in social studies of science.

Industrial sociology pioneered the study of the relationship between technology and society with its research on the connection between technology and organisation. Early on, Woodward (1965) and Child (1972) showed the connections between the structure of organisations and the core technology adopted, and Emery & Trist (1965) demonstrated the implications of new technology for work redesign and control. Closer to the spirit of the social shaping approach was the labour process theory tradition. Braverman (1974) reinvigorated the discussion of 'deskilling' with his seminal book Labour and monopoly capital, arguing that the evolution of machinery was shaped by the desire of capital to control labour as much as to increase productivity.[2] Ensuing debates over the theme of 'deskilling' revealed the complex interactions between various managerial and worker strategies affecting the design and implementation of technology.[3] Noble's (1979) study on numerical control (N/C) machine tools was classical piece of empirical study in the tradition, which demonstrated both the social choice existing in design and the uncertainty shown in implementation. Through detailed work on the contents of technology and emphasis on the structured social relations embodied in the technology, empirical researches in industrial sociology formed a backdrop to the emerging social shaping approach to technology.

SST has also been informed by the tradition of a critical approach to technology policy. From the time of colonial expansion, science and technology began to attract selective government patronage as a matter of state policy for their contributions to geographical and geological research, public health, and food production. As advances in science and technology proved to have greater implications for government, as in defence and industrial competitiveness after the First World War, science and technology became the subject of extensive state policy. However, conventional science and technology policy has been criticised in policy studies for having been based on the 'linear model' of the innovation

[2]Discussion on the labour process, see Thompson (1983) The nature of work: An introduction to debates on the labour process.

[3]For collections of case studies, See Zimbalist (1979) Case studies on the labor process, and Wood (1982) The degradation of work? Skill, deskilling and the labour process.

process, which treated technology as a 'black box', and for having been preoccupied with the issue of policy impacts and therefore ignorant of the shaping process of the policy itself. First, the assumptions on which the linear model of innovation has been built were found to be defective. The simplistic image of the relationship between science and technology, that is, the discovery of knowledge by science and its exploitation by technology, and the straightforward 'technology transfer' from academia to industry turned out to be problematic (Barnes 1982, Layton 1977). Second, research on policy revealed that the formation and implementation of policy itself is shaped by various political, economic, and social factors operating at both micro and macro levels; for example, values and interests held by participating individuals and organisations were conceptualised as examples of 'sociotechnical constituency' (Molina 1989), and broader contexts such as market structure, political culture, and the legal framework of a society were identified as 'the general characteristics of a society's technological ensemble' (Russell & Williams 1988).

Ideas from economics provided another important impetus for the emerging tradition of the social shaping approach. At first, mainstream economics was ill-equipped to deal with the phenomena of technological change. While technological development was recognised as an important factor for economic performance from earlier on, the most dominant school, neo-classical economics, has crucial weaknesses in developing adequate models of technological change. Perceiving technological change as an 'exogenous' variable outside of the economic system and assuming firms to choose from highly flexible and ever available production technologies for profit maximization, neo-classical economics treated technological change as 'black box' (Coombs, Saviotti & Walsh 1987). Within the economics discipline, a major corrective came from an alternative economics which takes an evolutionary approach. It replaces 'maximising' with 'satisfying', and introduces new concepts of 'technological paradigm' and 'technological trajectory' for explaining stability and change in technological innovation

(Dosi 1982;1988, Nelson & Winter 1977;1982). Addressing the problem of uncertainties in innovation and the issue of stability and dynamism in technological development, the evolutionary approach provided a common ground on which sociological and economic research on technology could communicate and more subtle and complex analyses of social shaping could be built.

Critically engaging with the new ideas on technological change in several disciplines, groups of like-minded researchers formed several distinctive research frameworks during the 1980s, such as 'social shaping of technology,'[4] 'social construction of technology (SCOT),' 'actor-network theory (ANT),' and 'system theory,' which became hubs of socio-economic research on technology. First, the social shaping of technology is a socio-technical research framework comparable to the so-called 'interests explanation' in science studies. An example is a MacKenzie & Wajcman's (1985) collection of case studies, whose title gives the name of 'social shaping of technology'. The case studies show how the design and implementation of military, production, and domestic technologies embody certain social interests of specific groups. Focusing on the interests located in the established social categories, such as class and gender, and emphasizing the role of state and political power, the social shaping of technology connects the contents of technology with the issues of broader social structure (Sørensen 2002).

Another distinctive school was formed around a number of scholars in the social constructivist tradition in the sociology of science, making a 'technological turn'. The social construction of technology (SCOT) approach models its research programme after the 'empirical programme of relativism (EPOR)' in that it rejects the retrospective distortion of the quasi-linear model of technological development and endorses a 'multi-directional model', treating successful and failed

[4]'Social shaping of technology' here is used in a narrow sense which is often compared with the 'social construction of technology'. The phrase is used in the rest of the thesis in the broad sense encompassing all schools explained in this section.

technology symmetrically. Case studies of the SCOT approach showed that different 'relevant social groups' ascribe different meanings to a given technological artefact, and the 'interpretative flexibility' results in technological debate or controversy which would be resolved by closure mechanisms of 'rhetorics' and 'redefinition of the problem' (Bijker 1987;1993;1995, Bijker & Law 1992, Pinch & Bijker 1984;1987).

From the tradition of history of technology and the internalist/contextualist debate within, came a 'system' approach. Criticising both internalist and contextualist histories of technology, Hughes argued that technology does not progress by inherent logic, nor it is determined by social, economic, and political contexts existing outside of technology. Rather a system builder or problem-solving inventor approaches a technological system in terms of a system of interconnected, technical, economic, social, and political elements, and build a sociotechnical system out of messy mixtures (Hughes 1979;1983;1986). Concepts, such as 'reverse salient', 'critical problem' were used to show that technological invention has system characters and it is important for system builders to recognise and exploit the feature in order to successfully build a technology system. For example, Carlson's work on Edison's motion pictures demonstrates the system feature by showing how an element of the system, cultural belief and social patterns, conceptualised as the 'frame of meaning', leads to certain strategies of system builders and the eventual breaking down of the system being built (Carlson 1992).

Works of another group of researchers, mainly those by Callon, Latour, and Law, formed a new approach called 'actor network theory (ANT)'. Proponents of the school argue that the construction of technological systems and the complex interaction between various actors involved in the process can be effectively analysed with the concept of 'techno-economic network (TEN)' or 'actor network'. Researches follow central actors, 'heterogeneous engineers' or 'engineer sociologists', who build techno-economic networks by combining a variety of material and non-material elements (Callon 1980, Callon & Latour 1981, Law 1986;1987). Using the metaphor of network and network builder, ANT has certain level of affinity with the system theory perspective, but the former is distinctive for two major reasons. First, the actor network theory is based on 'generalised symmetry,' in that the boundary between the material and non-material is blurred with the new concept 'actant'. Second, it avoids assuming established structural categories and perceives them as being built with the network in question through the strategies of 'translation' and 'enrollment' (Callon & Law 1982).

Since the social shaping approach emerged as a distinctive tradition in research on technology in the 1980s, it has continued to expand through the 1990s and made substantial advances both in the scope of its empirical research and in its theoretical sophistication. Researchers have conducted empirical researches in a greater variety of technological fields, and engaged in constructive dialogues with other research traditions on technology, both of which helped it to build a pool of substantial findings and more sophisticated and richer conceptual and analytical resources. Even though the social shaping approach is still characterised by its internal diversity[5] and certain tension over theoretical and methodological stances (Russell 1986, Russell & Williams 1988, Williams & Edge 1996), the research communities seem to have moved from an antagonistic stance and converged on anti-determinist, anti-linear, and anti-essentialist lines (Bijker 1993, MacKenzie & Wajcman 1999, Sørensen 2002), and while maintaining the core features of the social shaping approach, they exhibit some major themes of conceptual development.[6] This section briefly touches on three central themes; interest alignment, structure, and the wider concept of actors.

[5]See Williams (2002, pp.5-7) for possible causes for the continual diversity within the social shaping approach.

[6]Surveying the trend in the social shaping research on technology, Russell & Williams (2002) traces seven major themes of development: integration of insights from other traditions, social characters of technologies, contingent nature of innovation, regularities and structure of innovation, appropriation and use, wider concept of actors, and cultural shaping of technology.

First, the social shaping approach continues to emphasise the complexity and contingency involved in the innovation process. Researches on innovation, for example, continue to address the limitations of the linear model of innovation and of the 'linear plus' model, and call for an interactive model, highlighting the unpredictable and complex nature of the process (Russell & Williams 2002, Tait & Williams 1999). At the same time, this calls for an adequate explanation of the stabilisation process in which actors involved in technological development mould the potentially infinite possibilities into a particular shape. Actor network theory has analysed network building processes around technological projects in which central actors enrol other actors by translating their interests (Law & Callon 1992). Along this line, Jørgensen & Sørensen (2002) show different 'modes of performance' where actors employ different strategic manoeuvres to achieve favourable alignment. The SCOT approach continues to explore the working of closure mechanisms by which relevant social groups negotiate the common meaning of a technological artefact (Bijker 1995, McLaughlin, Rosen, Skinner & Webster 1999). The alignment of interests is further articulated with a variety of 'modes of coordination' (Disco & van der Meulen 1998), and also, the flexible and temporaneous character of the closure is examined (Rosen 1993). Alliance building around technological processes was also analysed with the concept of 'sociotechnical constituencies' (Molina 1995;1997) .

Second, the further development of the social shaping approach also sheds light on the structural forces which constrain actors' choices and shape regularities in technological development. The degree of emphasis on structural elements varies among different schools within the social shaping community and has changed over time. Early on, the school of social shaping represented, for example, by the collection of Mackenzie and Wajcman (1985), drew heavily on established social categories such as, state, class, and gender, and criticised the approaches of SCOT and ANT for ignoring broader context beyond the immediate environments of central actors (Russell, 1986; Russell & Williams, 1988).

The importance of social structure in technological change has been consistently argued in the last decade too (Rammert 1997, Wynne 1995). However, a visible trend in the social shaping approach is a shift from particular emphasis on one level of analysis to a balanced approach, as the SCOT approach incorporates a wider context (Bijker 1995) with concepts of 'technological frame' and 'sociotechnical ensemble,' and the structure-oriented social shaping school suggests the usefulness of combining macro and micro analyses (Russell & Williams, 1988). Also multi-level analyses were developed to address interactions among shaping processes at micro, meso, and macro levels (Geels 2002, Rip & Schot 2002).

Another important development in the social shaping approach of the 1990s is the widening of the conception of relevant actors and their terrain of activities captured by researchers. As researchers pay attention to the complex innovation processes with multiple actors and numerous loci of the main activities, the approach of ANT and SCOT, focusing on central actors' strategies and activities, have been criticised for its narrow perspective (Singleton & Michael 1993, Winner 1993). Innovation often seems to involve not only the multiplicity but also the shifts of centrality among those actors and locales, requiring conceptual tools to capture a distributed innovation or innovation journey (Cawson, Haddon & Miles 1995, Nicoll 1999). Jørgensen & Sørensen (2002) employ the concept of 'arenas of development' to follow unpredictable changes in locus and nature of arena, a configuration of key actors and contexts where participating actors engage in different 'modes of performance'. Others have proposed different terms and concepts, such as 'technological project' (Clausen & Koch 2002), 'arenas of negotiation' (Rammert 2002) as adequate foci and units of analysis for the complex innovation process.

2.2 The Social Shaping of ICTs

From the invention and diffusion of digital computers in the 1940s and 1950s, to the microelectronics revolution in the 1970s, the success of personal computers in the 1980s, and network revolutions in the 1990s, ICTs (Information and communications technologies) have achieved an astonishing series of successes in the latter half of the twenties century. Although there is disagreement over the nature and the role they play in past, contemporary or future social transformation, there seems to be general agreement that ICTs now form an essential part of modern industrial societies. Reflecting their importance, there have been many empirical researches and theoretical endeavours to understand the development of ICTs. This section reviews major perspectives on the relationship between ICTs and society, and the contributions made by the social shaping approach.

Since Cooke and Wheatstone made the most radical changes in communication technologies with the invention of telegraphy in 1837 when communication was separated from transport, improved communication technology with rapidly expanding reach helped to build international networks with enormous industrial, political and cultural implications through the 19th century. By the mid 20th century, further innovations such as radio, television, facsimile, and satellite communication laid the foundation for the emergence of 'global village' (McLuhan 1964). The invention of the digital computer in the 1940s was originally for military purposes, but its information processing power was soon put to commercial and academic use. Through four decades of innovations in terms of both architecture and component capacity, the digital computer became a reliable, powerful, and cheap means of information processing, and thus an indispensable part of modern life in the late twentieth century. Moreover, the potential of information technology was given a new order of magnitude when digital computers got connected through communication networks, creating the basis for a 'network revolution'.

In literature and journalism as well as academic writings, ICTs have become a focus of attention in discourses concerning radical social transformations of different complexions. Popular imagination was often captured by the futurologists' portrayal of utopian or dystopian images of radically transformed futures societies largely shaped by the advanced information and communication technologies. While Masuda (1981) presented a blueprint for an ICT-based utopia as 'Computopia,' Vonnegut (1952) warned against a society under absolute control of a giant computer. Economists and sociologists were also alert to the emergence of the 'information economy' and the changes in occupational structure in modern industrial society with the increasing importance of information. For example, Machlup (1962) traced the substantial growth of the 'information industry' in the U.S., and Porat (1977;1978) found with a more inclusive concept of 'information sector' that the U.S. is an information society[7] where a large proportion of the nation's economic activity is geared to the production of information goods and services. Bell (1973) paid attention to the changing mode of employment, the replacement of blue-collar with white-collar as the dominant labour force, and argued that modern industrial society was entering a new phase, called 'post-industrial society'. The idea of the discontinuity with and departure from a current society based on industrial production and a shift to another based on production and manipulation of information was popularised by writers such as Toffler (1980;1990), and Naisbitt (1984).

Meanwhile, from the late 1960s and early 1970s, economic recession and political instability loomed over Western industrial societies after decades of prosperity, prompting the search for the cause and the solution of the crisis at hand. In this context, the relationship between production technology on one hand, and new organisations of labour, long-term economic performance, and wider social implications had become major subjects for sociologists and economists. Most influential among theoretical endeavours to understand the situation were 'labour-process theories,' 'long-wave theories,' and 'neo-Fordism'. As was mentioned in section 2.1., the labour process theorists were interested in the social relations embodied in production technology. Empirical studies showed that

[7] For the history and debates over the information society, see Martin (1995) The global information society, and Poster (1995) The second media age. More critical approach is shown by Webster (1995) Theories of the information society, and Robin & Webster (1999) Times of the technoculture.

the capitalists' concern over labour control has shaped the design and implementation of production technologies, but also they found that the conflict of interests within managerial hierarchy and within workers, as well as the negotiations between them, influenced the outcome. Despite the common assumption of straightforward impacts of information technology, the studies on numerical control (NC) and computer numerical control (CNC) machine tools demonstrate the socio-economic shaping of information technology (Noble 1979, Sorge, Hartmann, Warner & Nicholas 1983, Wilkinson 1983).

Long-wave theorists focused on long-term, cyclical economic development, and the changes in the structure and organisation of industrial sectors interpreted as wave-like fluctuations. Among long-wave theorists there is no overall consensus on the primary causes of cyclical fluctuations of economic development,[8] but one prominent school of theorists, called Neo-Schumpeterian, argued for the essential role of innovation and, in particular, the role of ICTs in forming the current long wave. Freeman, Clark & Soete (1982), for example, suggested the concept of 'new technological system,' arguing that radical and ensuing incremental technological innovations and their diffusion lead to the recovery and boom of macro-economic performance. In particular, Coombs (1984a; 1984b; 1985), Blackburn, Coombs & Green (1985) and Soete & Dosi (1983) used the concept of 'mechanisation' to follow changes in production technology with increasing integration of information technology, and to assess its implications for the labour process and long-term economic development. The concerns of long-wave theorists are related to those of Neo-Fordists who argue that the crisis of the Fordist system deepens through the 1970s and the efforts to overcome the crisis leads to a series of innovations in production technologies and

[8]Classifications of the long-wave theories show the attribution of divergent primary causes of the long wave in economic development put forward by different schools of theorists, such as capital investment, innovation, war, capitalist crisis, trade, prices, etc. For classification schemes, See, Delbeke (1981) Recent Long-Wave Theories - A critical Survey, Marshall (1986) Long waves of regional development , and Goldstein (1988) Long cycles: Prosperity and war in the modern age.

organisational structure. This constitutes a shift from Fordism to Neo-Fordism, and the upswing of the current wave (Aglietta 1979). The Neo-Fordism is contrasted with the Fordist system of mass-production and mass-consumption of standardised goods, and characterised by automated and flexible production technologies, such as, CAD (Computer Aided Design), CAM (Computer Aided Manufacture), FMS (Flexible Manufacturing System), CAPM (Computer Aided Production Management) and CIM (Computer Integrated Manufacturing) and innovative logistical and labour techniques such as JIT (Just-in-Time), Flexible Specialisation, Group Working System, and the QWL (Quality of Working Life) movement (Edquist & Jacobsson 1988).

As shown above, the unprecedented pace of technological change attracts the attention of observers of modern society from popular futurologists to serious sociological and economic researchers. ICTs, among many fields of technology, are widely perceived as the main source of economic development and social, organisational, and cultural transformation of modern society. While the pure, unadulterated form of 'determinism' is rare in most discourses of social transformation, the relationship between technology and society depicted in many cases is still problematic because of their unbalanced emphasis on the impact of ICTs on society and lack of detailed analysis of the contents of technology and the process of its own shaping. Even when it does occur, the description of the shaping process is often dominated by explanations based on a single overriding rationale, such as class struggle, economic imperatives, and technological efficiency.

A major corrective for deterministic and simplistic interpretation comes from the social shaping researches on the formation and use of ICTs. Drawing on the legacy of researches on ICTs across many disciplines, researchers in the social shaping tradition explore ways in which the interactions of wide-ranging factors have shaped the formation and use of ICTs, refuting the popular technology-driven view of ICT applications. This section briefly reviews the contributions of socio-economic researches on ICTs in two main areas, digital computers and application of ICTs.

The digital computer is at the centre of modern information and communication technologies, and social shaping research shows that the structure of the computer itself has been shaped by historically contingent social, economic, and political factors (Williams 1997, pp.314-319, Williams & Edge 1996, pp.880-884). The early history of the computer shows a gradual separation between supply and use, and further segmentation of technical elements. Pelaez (1990), for example, demonstrates the role of political intervention in the crucial unbundling of IBM software from its hardware sales, and Fincham, Fleck, Procter, Scarbrough, Tierney & Williams (1995) describes the process of 'black-boxing' as a means of stabilising interfaces between segments of technological systems against the backdrop of increasing specialisation knowledge. A combination of several factors, such as apparent economic incentives (through economies of scale), high risks involved in capital-intensive production and uncertain market demands, had contributed to the creation of a style of 'architectural technology' which enabled suppliers to innovate, without problems of incompatibility and disruption in existing markets, by maintaining core product parts and only making changes in peripheral aspects of a product line, through several generations (Morris & Ferguson 1993). In the field of supercomputers, research demonstrates how particular requirements of dominant users steered the architecture of supercomputer by shaping the definition of performance criteria towards the needs of those users, and also how the suppliers' strategies prioritise among the diverse requirements of different users (MacKenzie 1991*b*, MacKenzie 1991*c*).

Software is another aspect of ICTs that attracted the interest of social research. For it forms a 'critical layer' between the general electronic information-processing mechanism and its actual applications in a variety of concrete social contexts, the design and implementation of software applications became an area where underlying values, motivations, and agendas of various social groups were pursued, clashed, and negotiated (Dunlop & Kling, 1991; Quintas, 1993; Williams & Edge, 1996, p.882). The production and implementation of software, for example, is subject to opposing visions and objectives. While the 'software crisis' led to the introduction of 'structured programming techniques', the issue of 'deskilling' of manual workers found its parallel in the organisation of software workers (Kraft 1977).[9] On the other hand, the Taylorisation of clerical office work was contested with the adoption of word-processors (Braverman 1974, Glenn & Feldberg 1979). Researches on software show that the perception of its nature, capability, and reliability is socially constructed and negotiated rather than given (Low & Woolgar 1993, MacKenzie 1991*a*), while the struggle for strategic resources in organisations also found a parallel in competition for control of the software and IT resources between groups of different expertise within organisations (Murray & Knights 1991).

Against many deterministic forecasts about the automated and flexible industrial applications of ICTs and radical transformation of contemporary society, the social shaping research also shows that the design and implementation of industrial ICTs have been social shaped. Williams and Edge (1996) surveyed the field and categorised three different types of applications as 'discrete' applications, 'integrated' applications and 'inter-organisational networks' with a discernible shift from the former towards the latter. Regarding discrete applications, the studies on machine tools and office automation tended to indicate the strong influence of existing social relations in shaping the decision on ICT design and implementation. In studies of machine tools, Noble's (1979) study shows a partial success of management in using the numerical control (NC) machine tools to increase their control over labour by appropriating and formalising machinists' skills, and also subsequent research on computer-numerical-control

[9]For a critique of the deskilling argument for software workers, See Friedman & Cornford (1989) Computer Systems Development: History Organization and Implementation.

(CNC) machine-tool job-design and implementation revealed a complex negotiation process among interested parties involved (Jones 1983, Wilkinson 1983, Williams 1987). Integrated application of ICTs with computerised organisational databases and networks is the core of new technological systems with automated design and manufacturing such as CAD (Computer Aided Design), CAM (Computer Aided Manufacture), CAPM (Computer Aided Production Management) and CIM (Computer Integrated Manufacturing). While those new ICT-based technological systems were expected to cause radical changes in organisational practices and lead to improved efficiency and flexibility, research conducted in the field demonstrated that particular assumptions about organisational practices embodied in the design of a system would later require further configurations both of the system being implemented and the organisation adopting it (Fleck 1993, Webster & Williams 1993). An 'inter-organisational network' is a system which connects a group of previously separate ICTs across organisations. It therefore creates enormous potential for efficient use of information, but also sets a formidable challenge in the building of a system beyond the control of any individual organisation. This requires the setting up of a protocol for information exchange and this turned out to be a difficult process, often relying on existing standardised practices or monopolistic and oligopolistic actors dominating the field as was shown in the cases of EDI (Electronic Data Interchange), bar-coding and EFTPoS (Electronic Funds Transfer at Point of Sale) (Kubicek & Seeger 1992, Williams 1995). Overall, as was shown in the studies of electronic commerce, the implementation of inter-organisational networks consists of incremental rather than radical innovations (Graham, Spinardi & Williams 1996, Graham, Spinardi, Williams & Webster 1993).

2.3 ICTs and Compatibility Standards

As shown in the previous section, one of the key trends in the current development of ICTs is a growing level of integration and networking of ICT systems, and greater demand for 'interoperability' within and between ICT systems as a result. Having existed as a part of technological system-building strategy for so long, technological standards, especially 'compatibility standards' emerged as an effective solution for the critical matching problem within ICTs. The vast majority of ICT systems were built around 'compatibility standards,' and this became a focus of attention for ICT-related research from the 1980s. This section surveys the nature and some historical examples of compatibility standards found in research, with a brief comparison between major approaches to the phenomenon of compatibility standards.

As was mentioned in the previous section, segmentation and specialisation in both hardware and software created a need for stable interfaces between the constituent parts with which a system is built (Fincham et al., 1995, Pelaez, 1990). Empirical studies attest the growing importance of interoperability within a system. Fleck (1988) found 'configuration' to be an essential part of the modern computerised system in that the building of a complex system into particular user settings often led to the configuration of standardised and customised parts rather than to a fully customised system. The 'pick and mix' strategy was also prominent in software package solutions (Procter & Williams 1996). The shift from 'discrete' to 'integrated' and 'inter-organisational' ICT systems is another factor encouraging interoperability, for the effective functioning of integrated or inter-organisational technologies depends on the interoperability of constituent parts (Williams 1997). Moreover, 'increasing return of adoption' and strong 'network externalities' have been recognised as common features of ICTs, and interconnection and interoperability became crucial factors for the success of ICT systems as network technologies (Arthur 1988, David 1985).

Since standards cover a variety of entities and activities in many different fields and contexts, there are many definitions and classification schemes emphasising different aspects of standards.[10] The major concern among the standards

[10] De Vries (1999, pp.159-172) grouped the classification schemes into three groups based on the main criteria, such as, 'subject matter', 'people and their activities and needs', and 'wider circle

and standardisations of ICTs is a type of standards called 'compatibility' standards. Compared to other major categories of standards, such as 'measurement' standards for common way of measuring, or 'quality' standards for assurance of minimum quality, compatibility standards deal with interfaces:

> Compatibility standards define the interface requirements allowing different core products, often from different manufacturers, to use the same complementary goods and services, or be connected together in networks (Grindley 1995, p.9).

> Compatibility standards concern fitting of interrelated entities to one other, in order to enable them to function together, for example, specifications for films and cameras, GSM telephone specifications (De Vries 1999, p.162).

Therefore, they provide common specifications for physical and conceptual components of ICT systems, such as components of computer architecture, interconnected and automated machinery, network infrastructure, software, communications protocol, and data formats.

The significance of compatibility standards in ICTs has been well documented in some high-profile cases of standards-related consumer products. The success of the IBM Personal Computer is a well-known example. When IBM decided to enter the nascent microcomputer market in 1980 with Apple and Tandy as its leading suppliers, IBM opted for an open standards strategy.[11] In contrast to the usual proprietary instinct, IBM decided to design an architecture which could be built with commercially available components and to make the architectural specifications available in order to encourage third parties to develop plug-in boards, peripherals, and software for the new system. Even though the IBM was a late entrant in the market, the open architecture successfully persuaded other manufacturers and software houses to adopt and use the specifications to produce complementary hardware components and much needed software

of interested parties and their activities' and lists an astounding range of standards types and classification schemes.

[11] Intel provided a new microprocessor, and Microsoft provided the system software (MS-DOS) for IBM, but both were available to other manufacturers of microcomputers. For a detailed account of the PC project, see Rodgers (1986) The IBM way and Chposky (1989) Blue magic: The people, power and politics behind the PC.

packages, which proved to be a crucial factor for the IBM PC and the 'take-off' of the microcomputer market as a whole. Within a few years of its first launch, the IBM PC architecture (Original PC, XP, and AT) became a de facto standard, dominating microcomputer market share with other compatible clones. The significance of the open architecture for the success of the IBM PC was made clear when IBM's attempts to re-close the standard with a new proprietary standard, in the PS/2, failed to convince the market of its benefits. Other high-profile cases show the importance of compatibility standards in product competition, such as the rivalry between VHS and Betamax and the success of the Compact Disc (CD) over Digital Audio Tape (DAT).

As integrated and networked industrial applications of ICTs began to replace simpler discrete applications, the demand for compatibility affects industrial applications of ICTs too. Computer Integrated Manufacturing (CIM), for example, required a complicated system of interconnection between a mixture of machineries and controllers from different makers and designs. The problem of communication was partially managed by using a proprietary system from a single vendor or installing customised communication networks, but not without difficulties (Dankbaar & van Tulder 1992). An example of an attempt to build an open-standard solution is MAP (Manufacturing Automation Protocol). Initiated by GM (General Motors) with the participation of many other European, U.S. and Japanese firms, MAP was based on the structure laid down by the OSI (Open Systems Interconnection) reference model. The development of EDI (Electronic Data Interchange) demonstrates the central role of compatibility standards for the successful implementation of inter-organisational network systems. As EDI is defined as 'set of message standards to enable the exchange of commercial transaction data between autonomous application systems without human intervention' (Pfeiffer 1992), the working of the system is dependent on the establishment of protocols and data format standards. Research on EDIFACT (Electronic Data Interchange For Administration, Commerce and Trade) shows a shift from attempts at proprietary, local, or national standards to open, industry-wide, and international standard (Graham et al. 1993).

One consequence of the growing prominence of compatibility standards is the increasing attention paid to the phenomenon from within and without the immediate technological fields of ICTs. The area of technological standards had been perceived as a distant and arcane world, the preserve of engineers and scientists who seek practical solutions for matching problems. However, the realisation of its prominent role for contemporary ICTs began attracting the attention of academia, the business community, and government, as well as the public in general, stimulating efforts to understand the phenomenon and exploit its potential. Therefore, compatibility standards became a concern of researchers from different disciplines and traditions, as well as designers, implementers, and users of the standards. Three of the most influential and common perspectives on standardisation are identified as technocratic, economic, and socio-political, though such categorization runs the risk of oversimplification.

Widely accepted by practitioners and sustained by the formal standardisation organisations (SDOs), the technocratic perspective understands standardisation as a collective search for a technically superior solution for a technical problem. Standards are a means of achieving an 'optimum degree of order,' and 'should be based on the consolidated results of science, technology and experience' (ISO/IEC 1996). And standards offer solutions for matching problems for more and more specialised and segmented technological systems (De Vries 1999). When it is not interfered with by other 'social' and 'economic' factors, 'the decision can be made purely on technical merit, and it is simply a question of determining the relative technical merits of the alternatives' (MacKenzie 1980, p.4). This does not mean that the technocratic approach ignores the economic and social processes involved in standardisation, but it is rather a normative position to be aimed by standards practitioners. Addressing the international symposium on information technology standardisation, the chairperson of ISO/IEC

JTC1 cited 'political interests' as one of the major inhibitors of standardisation rationality (Rankine 1990). Technological efficiency and technological rationality should be the main criteria for decision-making on technological standards. The economic perspective became the most prominent one through the 1980s.[12] From this perspective, compatibility standards are primarily economic phenomena which can be explained by the special economic character of certain types of technology and the strategic behaviour of the actors under various circumstances. Economists are interested in peculiar patterns of behaviour of network technologies which defy the generally accepted economic principle of 'diminishing returns' (Farrell 1990) and exhibit instead 'increasing return to adoption', and 'network externalities' (Katz & Shapiro 1985, Katz & Shapiro 1986). Compatibility standards work as a linchpin of those network technologies and contribute to the occurrence of 'path dependency', bandwagon effect', and 'lock-in' (David 1985, David 1986, Farrell & Saloner 1986*b*, Farrell & Saloner 1986*a*). The economic approach addresses the problems of standardisation and corporate strategies to exploit the phenomena of market competition (Grindley 1995, Swann 1987, Swann 1990). In contrast to the two perspectives above, the socio-political perspective approached standardisation as a social process in which a variety of interests of actors were aligned, clashed, and were negotiated (Jørgensen & Sørensen 2002, Williams 1999). As a study on the setting of EDI standards shows (Graham, Spinardi, Williams & Webster 1995), standard-setting is a political process in which concerned parties seek to realise partisan interests as well as common goals. Compatibility standards became both the targets and products of interest alignment (Cowan 1992, Fleck 1988, Williams 1997). Factors considered in this socio-political process also include the cognitive framework of actors, institutional infrastructure, shaping and constraining visions, as well as resources of actors involved in the standard-setting process (Egyedi 1996;1997, Schmidt & Werle 1992;1998).

[12] For a widely used review of the economic analysis of compatibility standards, see David & Greenstein (1990) The economics of compatibility standards: an introduction to recent research.

2.4 Conclusion

This chapter has introduced the research tradition of social shaping of technology (SST), and its contributions to the understanding of information and communication technologies (ICTs) and compatibility standards. First, the chapter introduced unique features of the social shaping approach. Drawing on various traditions of research on technology, the social shaping tradition has developed a distinctive approach to the subject of technological change. It shifts the centre of attention from the effects of technology upon society to the contents of technology itself, and emphasises the presence of social choices during the design and implementation process, and attempts to model the complex shaping process involving social, cultural, organisational, and political factors as well as technological ones. As the ICTs became a prominent feature of modern industrial societies and a focus in many discourses of radical social transformation, the social shaping approach addresses the problems of deterministic perspectives prevalent in those discourses and reveals the social character of the ICTs. The chapter then focused on the increasing demand for 'interoperability' and compatibility standards as its solution. The nature and significance of compatibility standards in ICT systems were explained, and three main theoretical approaches to compatibility standards were compared.

Chapter 3

Methodology

As the research on the Korean national coded character set standard was designed and carried out, a rich tradition of case studies of the social shaping approach has been a main source of inspiration. Within the social shaping approach, there have been continuing debates over methodological issues, such as epistemological and ontological standpoints, appropriate units of analysis, and best methods of investigation (Russell & Williams, 1988; Williams & Edge 1996, pp.889-892). Nevertheless, the majority of the empirical researches that have formed the backbone of the social shaping tradition have been various forms of case studies on particular sites of technologies, focusing on the design and implementation process of the technologies in question as well as their impacts on society. The detailed examination of the contents of technology and its context have served well the objectives of opening up the black box of technology and revealing complex relationships between society and technology. The combination of a focused reconstruction of the social processes around particular technologies on one hand, and the sociological analyses based on it on the other, marks the distinctive case study method of the social shaping approach, and this is the broad methodological tradition that has informed the research on the Korean controversy.

Chapter three describes and justifies the methodological approach and methods chosen for the research reported here on Korean national coded character set standardisation. First, section 3.1 examines case study research design in general, and a typical version adopted in many social shaping approaches and here. Case study design is identified as a type of research design among elements of social research, and two potential sources of problems with case study design are discussed: the time-scale and quality criteria of social research. Section 3.2 describes the design for the case study of the Korean coded character set standardisation, and the methods of data collection and analysis used in the research.

3.1 Case study Design

While there is no consensus on the exact boundaries and terminology of the constituent elements of social research, it is generally agreed that social research consists of layers or levels of building-blocks ranging from the philosophical foundations of the research to concrete data collection methods. Among a variety of models, the one used here is a four-level or four-element structure. At the most conceptual or fundamental level, there are ontological and epistemological foundations, basic questions concerning the nature of social entities and their accessibility to researchers. At the second level, there are different research strategies or 'logics of enquiry'. Partly reflecting the assumptions carried from the previous level, the research strategies set the logical foundations of the research, well-known examples of which are inductive and deductive strategies. Over these foundations, there is a level of research design which determines the overall framework of research to be conducted in the field, such as experimental, cross-sectional, or comparative design. Then, at the most practical and concrete level, there is a collection of research methods, actual techniques and procedures for collecting data. Given that the hierarchical model offers a general guideline for structuring social research,[1] the main foci of enquiry here are the level of research design and the methods embodied in the case study design.

[1]Social research is an iterative rather than linear process among its research elements, therefore the discussion of social research in terms of level or element is for analytical simplicity.

Some authors have identified the case study with specific types of research methods, such as participant observation and ethnography.[2] Others, however, appreciate more general features of the case study and categorize it as a research design. Definitions and comments quoted below reflect the qualities of the case study as a research design.

> The case study, then, is not a specific technique. It is a way of organizing social data so as to preserve the unitary character of the social object being studied (Goode & Hatt 1952, p.331)

> An umbrella term for a family of research methods having in common the decision to focus on inquiry around an instance (Adelman, Jenkins & Kemmis 1977).

> Case studies take as their subject one or more selected examples of social entity - such as communities, social groups, organisations, events, life histories, families, work teams, roles or relationship - that are studied using a variety of data collection techniques (Hakim 1987, p.61)

> An empirical inquiry that: investigates a contemporary phenomenon within its real-life context; when boundaries between phenomenon and context are not clearly evident; and multiple sources of evidence are used (Yin 1989, p.23).

> The researcher explores a single entity or phenomenon (the case) bounded by time and activity (a program, event, process, institution, or social group) and collects detailed information by using a variety of data collection procedures during a sustained period of time (Creswell 1994, p.12).

According to the classification of main research elements and definitions of case study above,[3] the case study is a type of research design characterised by intensive examination of subject matter in context and the employment of various research methods, and it is also the most predominant empirical research design adopted by the social shaping approach. Since their early publications of

[2]For the revival of interest in case studies in the 1980s, and its identification with specific types of research methods, see Mitchell (1983) Case and situation analysis, and Platt (1988) What can case studies do?

[3]Blaikie (2000, pp.36-41) shows the breadth of the meanings ascribed to the concept of research design from one as narrow as the single experiment to one as broad as to encompass virtually the whole process of social research.

empirical studies (Bijker 1987, Elliott 1988, MacKenzie & Wajcman 1985), the researchers in the social shaping tradition have conducted detailed investigations across a number of technological fields into the shaping process of particular technologies and the context in which the technology is embedded. The notion of 'strategic research sites' below demonstrates the affinity between the research design of the social shaping approach and case study design;

> Clearly, part of the task of the emerging new field of technology studies is the identification of research sites at which the complexity of the seamless web is manageable but which at the same time serve to capture key aspects of technological development. We call such locations strategic research sites (Bijker et al. 1987, p.191)

However, a particular aspect of the conventional image of the case study, contemporaneity, is seen as potentially problematic in the case study design adopted here and in the social shaping approach in general. First, more often than not the case study in social research is seen to cover contemporary phenomena exclusively. As Yin (1989, p.23) emphasises in his definition, the case study is usually perceived as an investigation of contemporaneous phenomena, frequently compared with the subject matter of history. However, the social shaping approach has developed as an interdisciplinary field with history as an integral part. For example, contextual historians of technology have pioneered the documentation of specific instances of technologies in close relation to their social contexts (Cowan 1983, Hughes 1983, White 1962), while SSK (Sociology of Scientific Knowledge), as a main inspiration for the social shaping approach to technology, was itself founded on the accumulation of historical case studies. Second, the case study design has been employed from early on in many social research projects for a single event, community, or organisation with strong contemporary tone, and some authors seem to accept the narrow sense of case study with limited time span (Bell 1993, Blaxter, Hughes & Tight 1996). Against the tendency, MacKenzie (1990, pp.7-8) called for a historical perspective in his study on missile guidance technology, and warned against case studies restricting their investigation to a limited period of time, and therefore failing to incorporate some important but slowly changing factors as relevant variables. The lack of historical perspective, however, is not an innate feature of the case study design itself, as some case studies, including ones under the social shaping tradition, successfully incorporated the time dimension in their research. It seems that the time-scale of the case study reflects researcher's judgment on the adequacy of factors to be included in the case study and the appropriate time span needed to understand them.

As a social research design, the case study is sometimes subject to typical evaluation criteria of social research in general, such as reliability, validity, and generalisability.[4] Reliability concerns the potential for the bias of researchers to affect the findings of the research. High reliability typically means the stability of measurements in quantitative research processes, and it is also related to the idea of replicability, that is, whether the research can be replicated by other researchers with essentially the same results. Validity is the measure of integrity of the conclusion, and normally concerns the degree of confidence placed in the causal relations found in quantitative research. Generalisability, also called external validity, concerns the applicability of the findings beyond the context of the research, and it usually deals with the sample's representativeness of the general population. Since those evaluation criteria have been formulated with specific preoccupations of quantitative research, such as, measure, causality, generalisation, and replication (Blaikie 2000, pp.247-250; Bryman 2001, pp.74-76), their application to case study design with a more qualitative flavour often produces poor standing and becomes a source of criticism against case study design (Yin 1989, pp.21-22).

[4] Different authors propose and subscribes to various classification schemes and terminology for those widely used criteria, such as reliability, validity and generalisability. The term, external validity, is commonly used for the concept of generalisability here.

Due to the inherent bias of those criteria for quantitative research, the relevance of the criteria for case study and qualitative research in general has been contested or adapted with some reservations. For example, Mason (1996, p.21) reframes the criteria as 'different kinds of measures of quality, rigour and wider potential of research' which could be obtained in qualitative research. LeCompte & Goetz (1982) interpret the meaning of validity and reliability in the context of qualitative research and claim their relevance, but question the generalisability of the case study. Also, some authors opt for alternative criteria deemed more suitable for assessing qualitative research. Lincoln and Guba propose trustworthiness as a new set of primary criteria, under which the qualities of dependability, credibility, transferability should replace reliability, validity and generalisability respectively (Lincoln & Guba 1985, Guba & Lincoln 1994).[5] Most proponents of case studies claim generalisability for the research design. It is argued that the customary criticism of the case study as being of low generalisability is based on the confusion between 'statistical inference' and 'logical inference' (Mitchell 1983, pp. 199-200), or 'statistical generalisation' and 'analytical generalisation' (Yin, 1989, p.38). Mitchell points out that;

> Statistical inference is the process by which the analyst draws conclusions about the existence of two or more characteristics in some wider population from some sample of that population to which the observer has access. Scientific or causal or - perhaps more appropriately - logical inference, is the process by which the analyst draws conclusions about the essential linkage between two or more characteristics in terms of some systematic explanatory schema - some set of theoretical propositions (Mitchell 1983, pp. 199-200).

Therefore, the case study design is cleared of the accusation of being defective as social research design. The main criticism directed at case study design proved

[5] In their newly proposed scheme, the 'trustworthiness' mentioned here consists of credibility, transferability, dependability, and confirmability. Lincoln and Guba also proposed authenticity (including fairness and ontological, educative, catalytic, and tactical authenticity) as another set of criteria, concerning wider issues of social research. For more details, see Lincoln and Guba (1985) Naturalistic inquiry, and Guba and Lincoln (1994) Competing paradigms in qualitative research.

to be founded on some misconception over the nature of the case study and the widespread biases towards a more quantitative research approach which dominated social science for decades from the 1950s.

3.2 The Case of National Character Set Standards Controversy

The case study design provides an adequate framework for empirical research on the standardisation of a national coded character set in South Korea. Even though the research is focused on a specific range of technological standards, the development of a Korean character set involved multiple actors at different levels and different locales, and the standardisation went through various stages with shifting alliances of actors and changing environments. Therefore, the understanding of the standard-setting process requires a detailed study of the contents of standards and the examination of contexts in which a series of standards have been formed, understood, maintained, supported, criticised, or replaced by various alliances of actors over time. The case study fits the bill with its emphasis on intensive examination of the subject matter within its context, as explained in the previous section.

When it comes to the actual historical reconstruction of the case, the close relation between the technological artefacts and their context raises a question of drawing a case boundary, that is, including as many relevant factors as possible to allow a satisfactory description of the case but leaving out certain factors in order to keep the research project feasible. The research objectives and questions set out in the introductory chapter offer the necessary test for relevance. The boundary of the case is drawn with a series of Korean national character-set standards and the immediate local context of the standard-setting at the centre, and international standards regimes at the periphery. The former includes major actors involved in the standard-setting process, and social, organisational, economic, political, cultural, and technological environments around the process. International character-set standard regimes have always been an important factor in shaping the Korean national standard formation, but the processes by which those international standards have emerged are only partially included in the case apart from the emergence of the third-generation international standards where the boundary between the national and international standard constituencies was blurred due to increased interaction between them.

Data collected for the case are sources of description and analysis of the case. The two main data-collection methods used for the case study are documentary research and interview. Participant observation and ethnographic techniques, common in case study design, were excluded because most of the Korean national character-set standards-setting process had happened from the early 1980s to the mid-1990s, even though the most intensive public protest in 1998 and closure of the controversy itself in 2000 were contemporary events. Therefore, documents of various kinds were systematically collected and analysed as the main method of reconstructing the chain of historical events relevant to the Korean national coded character set standards-setting process. Interviews were conducted with actors involved in the design, implementation, and use of the standards.

Documents collected for the case study come from a variety of sources and this includes all of the primary, secondary, and tertiary documents. Standards documents of both Korean character sets and international character sets from formal standards development organisations and consortia were definitive reference points. Memos, reports, and minutes of Korean JTC1 SC2 and SC2/WG2 are important sources of standardisation activities from inside. Minutes of ISO/IEC JTC1 SC2/WG2 meetings and reports of Unicode technical committee meetings provide an invaluable insider's view of the standardisation process. Government documents collected include white papers and reports on computerization projects, industrial policies, and standardisation activities and relevant statistics.

Records of public hearings and advisory experts' meetings were also used. Media outputs form a key part of data collection. Major nation-wide newspapers with general coverage and specialties in electronics feature character-set standardisations during the moments of controversies. Specialised computer magazines, in particular, produced regular feature articles on the character-set standards as well as special articles following the controversy. Both newspapers and magazines were used by supporters of competing character sets as main channels for persuading potential participants in the standardisation and the public in general, and therefore, the diverse perspectives of developers, industry experts, academics, users, and government officials were published in the media. Abstracts, indexes and subject bibliographies were surveyed in order to locate relevant documentary sources.

As for the structure of research design itself, the quality of evidence used for the research is paramount for the value of the output of the research. For assessing the quality of documentary evidence, Scott (1990, pp.19-35) proposed four quality criteria for documentary sources: authenticity, credibility, representativeness, and meaning. Authenticity concerns whether the documents used are genuine, of unquestionable origin. Credibility 'refers to the extent to which the evidence is undistorted and sincere, free from error and evasion'. Representativeness concerns the question of 'typicality' of the document.[6] The meaning criterion, on the other hand, deals with the clarity and comprehensibility of the document. The testing of those criteria on documentary sources alerts researchers to the danger of assuming those qualities, and enables them to address limitations of the sources in case of low grading on those criteria. For most of the documents used in the research here, the criteria of authenticity and meaning raise little concern. Documents from governments, standards committee, public hearings, conferences, standards documents, minutes of Korean JTC1 and ISO/IEC

[6]Scott (1990, pp.24-28) further explains that the typicality criterion does not mean that research should be based on typical or representative documents, but rather it means that the researchers and the audience of the report should be aware of the extent to which the document is not representative.

JTC1 are certified with index numbers and copies from different sources concur in the contents and form. Those documents are also straightforward in terms of the contents, and, even though they vary as to the degrees of expertise assumed in their audience, there is very little element of confusion in their meaning. An exception in this regard would be some magazine articles where authorship is not clear with the 'editorial board' being used as the author name. However, those articles appeared in a small number of specialised magazines and the authorship could easily be ascertained, so there arose no suspicion over whether the authors were in a suitable position in terms of their access to events reported. In terms of credibility and representativeness, there arose some concerns due to conflicting factual accounts mainly of the properties of the technological artefacts during the controversy. Descriptions of competing character-set standards have been largely uniform within each supporter group, but they are sometimes widely divergent between groups. The veracity of rival claims has been contested between discussants throughout the controversy. However, the conflicting assessments of the technological properties seem to reflect values and priorities given to certain technological artefacts by different groups rather than error or distortion in the production of documents. Representativeness has some relevance in the case too, for similar reasons. Throughout the Korean controversies, each of the rival constituencies of competing character-set standards developed sympathetic relation with certain media channels (newspapers, magazines, and on-line discussion groups), and secured favourable representation in standards-related bodies (standards bureau, advisory committee, and Korean JTC1 etc.). Moreover, the stance of the media and the make-up of the public or quasi-public bodies have been changing as the controversy unfolded. Therefore, there is a need for a careful survey of the media coverage and the decisions of public bodies over time, in order to avoid undue representation of one side over the other from documentary sources.

Along with the documentary research, some of the prominent individuals involved in the Korean character-set standardisation were interviewed as a means of data collection for the research. The interview has been recognised as an essential tool of data collection in the qualitative research tradition. The interviews were carried out with two main potential contributions in mind. First, the interviews with participants of the controversy were expected to provide an invaluable source for historical reconstruction of the events. Interviewees' recollection of the events could be used to confirm documentary sources, fill the gaps left by other sources, and help to locate further data sources. Second, the interview is an effective and sometimes the only way to access personal experiences, such as opinions, values, feelings held by individuals towards the technological artefacts concerned and the unfolding of the controversy as a whole. In this sense, the interview and documentary research complement each other in obtaining a fuller and more accurate image of the standardisation process.

Interviews, as a data collection method is defined as:

> encounters between a researcher and a respondent in which the latter is asked a series of questions relevant to the subject of the research. The respondent's answers constitute the raw data analysed at a later point in time by the research (Ackroyd & Hughes 1983, p.66).

Beyond this basic definition, there are variations in many aspects of the interview, such as the design of questions, procedures, and control over the answers, and so on. The variety of interview methods is commonly categorised into three main types: structured, semi-structured, and unstructured interviews. Structured interview is the most common type in survey research where standardised procedure and uniform structure are used to obtain a high level of 'comparability' between responses for discerning causal relations and for generalising such relations into the population. A semi-structured interview is different from the structured one in that the questions are framed more generally and interviewers are given latitude to ask further questions for clarification and elaboration. The interviewees are allowed to answer on their own terms, but there are still elements of structure for comparability. It is characterised by 'thematic guide with probes and invitations to expand on issues raised' (Fielding 1988, p.212). The unstructured interview is a radical departure from the idea of the structured interview in its flexibility and open-endedness. In the unstructured interview, the researchers face their interviewees with just a list of topics or issues to be covered, called an 'interview guide' or 'aide-memoire', compared to a list of set questions to be asked in the structured or to some extent the semi-structured interview. Interviews are normally carried out informally, and interviewees are allowed to talk about the topic in their own frames of reference to reveal their point of view on the issues. So-called 'rambling' is encouraged rather than suppressed, and the interviewee leads the direction of the interview away from the original question or subject during the interview. With its emphasis on in-depth, focused, but flexible interview arrangements in an informal setting, the unstructured interview has been conceptualised by various researchers with similar interview types, such as 'intensive interview' (Lofland & Loftland 1995), 'ethnographic interview' (Spradley 1979), 'qualitative interview' (Mason, 1996), 'in-depth interview,' and 'focused interview' (Merton, Fiske & Kendall 1956). The interview classification scheme above, however, shows instances of abstract ideal types conceptualised along a wide spectrum of possible arrangements of the interview in social research. Actual interviewing practices in many social research projects are more likely to be a mixture of the categories shown above, depending on the particular circumstances of the research project in question.

In order to capture rich factual details and personal experiences in a flexible format, the interviews were conducted as a mixture of semi-structured and unstructured interviews. Also, there were practical difficulties in the way of using more structured interviews, for many of the interviewees took part in different stages of the controversy with different expertise and different concerns, and therefore the application of standardised questions to the whole range of issues seemed unfeasible. A range of topics to be discussed was selected, and lists of questions were prepared under each topic, both of which were drawn from the preliminary research on the Korean controversy. Major topics of interview were selected for each interviewee according to the expertise of the interviewee and the period of participation in the standard-setting process. During the course of the interview, however, the prepared questions and their sequence were used as a rough guide in order to cover the all relevant topics in balance within the given time of interview. Interviewees were encouraged to answer in their own terms, and allowed to follow any line they thought relevant to the issues under discussion.

Interviewees were selected according to their expertise on the issue and experiences in the standardisation process. Ten interviewees were finally selected and interviewed.

> Ahn, Sang-Kyu - Leader of Korean engineering team of Desktop Application Division (for Office Suite) in Korea Microsoft Inc. As a programmer, he involved in Korean language related engine development for Microsoft, such as, Korean IME, spelling checker, grammar checker, word breaker.
>
> Byun, Jung-Yong - Professor in Computing science department of Dong-Kuk University. He has been Involved in Korean information processing in general, especially in Korean character set standard setting from early stage. As one of active member of the Pro-Johap groups during the first controversy around 1987 national standard, he criticised the Wansung, syllable encoding approach, and proposed a character set called 'Jung-Eum-Hyung' which is a variable length Jamo encoding scheme.
>
> Hong, Yoon-Pyo - Professor in Korean literature and language department of Dan-Kuk University. One of main figures from academics who provides government and the IT industry with necessary expertise on Old Korean. One of critics of national standard, KSC 5601:1987. He helped Haansoft to develop powerful capability in terms of Old Korean usage and later helped Korean Microsoft as well as Haansoft for the Unicode based Korean word processor development.

Jun, Sang-Hoon - Founder of the Korean Language Information Processing Laboratory(KLIPL). He has BA in Korean language, but later became a programmer specialising in Natural Language Processing and founded the KLIPL. He wrote several articles about the natural language processing and the Korean character set standards issue in IT related magazine.

Jung, Nae-Kwon - Vice president of Dreamwiz Inc. He worked as one of main programmer in Haansoft, and involved in developing HWP. Starting as an amateur computer mania while he was a Korean language teacher, he became a first rank professional programmer in Korea. He is also the writer of the first Korean spelling checker.

Kang, Tae-Jin - CEO of ThinkFree Inc. He wrote one of the first generation Korean language word processor in Canada, pioneering application level support for Korean input/output. With the enactment of Intellectual property rights in Korean, he came to Korea and began his career as entrepreneur in IT field. He also worked for Haansoft. He was one of major figure in the character set standard controversy against the 1987 national standard, and also involved heavily in the enlargement of Korean repertoire in Unicode.

Kim, Heung-Kyu - Professor in Korean language and literature department of Korea University. He has been Involved in several Korean language related government projects and national character standard setting, in particular, with expertise in the Old Korean and Chinese script used in Korea.

Lee, Jun-Hee - A software developer from ICUBE (multimedia company). He was a former employee of Haansoft. He wrote a section of the influential study sponsored by the Ministry of Culture, 'Studies on Korean character set standards' in 1992. He had been actively involved in Pro-Johap campaign towards 1992, which led to the 1992 dual national standards setting.

Lim, Won-Sun - One of new generation of young elite government officials in the Ministry of Culture. He involved in the character set standardisation process during 1990-1992.

Suh, Hyun-Jin - Editorial writer in The Electronic Times. He has been working as a journalist in specialist paper, The Electronic Times since 1988. Base on his experiences in the field, he wrote a book, 'The first history of computer in Korea' in 1997.

3.3 Conclusion

Following chapter two, which surveys the theoretical background of the research on Korean character-set standardisation controversies, this chapter examines the research design and data collection methods used. As a research design, case study design is chosen, for its general features proved to offer an adequate framework for focused reconstruction of a complex social process. In order to be used for the research in question, the two potential sources of problems were examined. First, even though the common practices of case study design usually concentrate on contemporary events or processes within a relatively short time span, the social shaping tradition has successfully integrated case study design with historical perspective. Second, the criticism levelled against the case study - poor generalisability - has been found to be misdirected, for the relationship between theory and case study is based on 'analytical generalisation' rather than 'statistical generalisation'.

Data collection methods used in the study are also explained in this chapter. Documentary research was used extensively from the stage of preliminary research to the corroboration of the interview material. Documents were systematically collected from a variety of sources in many forms, and they are an important source for the reconstruction of historical events and access to the recorded perspectives of organisations and individuals involved in the standardisation process. As evidence used in the empirical research, the quality of the documents is an important issue and four quality criteria of documents were discussed in relation to the sources used in the research. Interviews with the participants of the standards-setting process are the other main source of data used for the research. In order to extract rich details of specific situations and to be responsive to new insights from interviewees, semi-structured and unstructured interviews were conducted. Interviews provided invaluable sources for the research, for they helped to fill the gap left by the documentary sources, opened unexpected avenues for the research, and offered chances to access personal values, feeling, and opinions held by participants in the standards-setting process.

CHAPTER 4

Coded character set standards

Character encoding in digital computers is a process in which various elements of a text (alphabets, numbers, and other symbols) are chosen, assigned with numeric values, and arranged in a serialised bit stream.[1] In the form of binary numbers of 0 and 1, text information can be processed and stored in digital computer whose internal data representation is based on electronic binary signal. For example, character encoding with ASCII, one of the most famous varieties in coded character set standards, the English letter 'A' is represented by a string of binary numbers, 1000001. It is a basic yet crucial layer of mediation between the binary nature of digital computer and graphical nature of handwritten or printed characters.[2]

As a medium of storing, processing, and exchanging information, it soon became clear that there was a need for a common way of encoding characters, a standard with which users could share information across different machines and applications. Various features should be harmonised for standardisation, such as, the selection of character repertoire, length of bit for a character, and allocation of specific bit value to characters. In order to achieve a favourable environment for the information sharing, there has been a series of attempts to

[1]'Bit' is short for 'binary digit', either of the two digits 0 and 1 in the binary number system (Oxford Dictionary of Computing, p.44).

[2]In character encoding, characters are 'the smallest components of written language that have semantic value', in abstract form, and this is differentiated from glyphs 'which represent the shapes that characters can have when they are rendered or displayed' (Unicode Consortium 2000).

standardise character encoding, creating a range of industry wide, national, regional and international standards.

A particular focus here is the development of three major international character set standards regimes, ISO 646, ISO 2022, and ISO/IEC 10646-1. A nation wide coded character set standard was first developed in U.S. where the development of digital computers, its diffusion, and commercial exploitation were most prominent. Stimulated by the success of ASCII, other countries followed suit, developing national coded character set standards. The national level standardisation efforts, in turn, inspired a regional or even international standardisation of coded character set for the unconstrained information sharing across borders. International standardisation such as ISO (International Organisation for Standardisation), CCITT (International Telegraph and Telephone Consultative Committee), and European Computer Manufacturers Association (ECMA) at European level produced the first and second generations of international coded character set standards, ISO 646 and ISO 2022 respectively. Later in 1987, ISO and IEC (International Electrotechnical Commission) set up a Joint Technical Committee 1 (JTC 1) for coordinated standardisation efforts in the field of information technology. In the early 1990s, JTC1 and Unicode, an industry consortium, joined their efforts and produced the third-generation international character set standard, ISO/IEC 10646-1 and Unicode.

This chapter intends to provide general knowledge about the character set and major features of three generations of international standards which set the backdrop of the development of Korean national character set standards. Section 4.1 explains the basics of coded character set, followed by three sections that survey the three different generations of international standards. First, section 4.2 introduces one of the earliest and most successful character set standards of all, ASCII and its internationalisation, ISO-646. Section 4.3 explains the ISO-2022 extension techniques developed to cater for the larger repertoire requirements beyond the remit of ASCII and ISO-646. Section 4.4 then, explains the most recent developments in international standards, ISO/IEC 10646-1 and Unicode, which laid important foundations for multilingual information process.

4.1 Coded Character Set

As mentioned earlier, the character encoding is 'as mappings between the character sequences that users manipulate and the sequences of bits that computers manipulate' (Dürst, Ishida, Wolf & Texin 2004). Central to the process is a 'coded character set'. The two most authoritative definitions of coded character set are as below:

> A set of unambiguous rules that establishes a character set and the one-to-one relationship between the characters of the set and their bit combinations (European Computer Manufacturers Association 1991, p.2).

> A character set in which each character is assigned a numeric code value. Frequently abbreviated as character set, charset, or code set (Unicode Consortium 2000, p.985).

A coded character set, or commonly called 'character set,'[3] therefore, sets rules for character encoding, and embodies major decisions over technological features, such as, the selection of character repertoire, size of codespace, and the assignment of code point to each character. One pivotal decision to be made for each coded character set is the size of the bit combination to be used for encoding each character. For example, ASCII uses a 7-bit string to encode a character, while Unicode allocates 16-bit per character. In principle,[4] the number of bit stream of the given character set dictates the total number of unique bit patterns, called 'code point' it can create. In turn, this sets a limit on the maximum number of characters usable with the given character set. In general, a n-bit code could produce 2^n unique bit combinations. Therefore, a 4-bit code can make 16 ($=2^4$)

[3]'Character set' itself is defined as 'a collection of elements used to represent textual information' (Unicode Consortium 2000, p.985) but when there is no danger of confusion, the 'character set' is used for 'coded character set' hereafter, except for in headings and in formal designations.

[4]There are ways in which maximum character repertoire could be enlarged on the same bit size, such as shift code explained in section 4.2

different bit patterns. A 5-bit code 32 ($=2^5$), and a 6-bit code 64 ($=2^6$) and so on. Being a crucial factor for a given character set, the number of bits used for encoding each character is normally used as a reference or as a classification scheme, such as, 7-bit code, or 8-bit code.

Considering the relation between the number of bits and the size of character repertoire, it seems that the larger the bit combination, better it serves the user requirements of a large character repertoire. The applications in which the character set would be used demanded more and more variety of characters as more complicated applications began to be realised. However, there is a trade-off between hardware and communication costs on one hand and the requirements of the application on the other. A larger bit stream per character means that more registers are needed to hold the same amount of data and more transfer time is needed on communication lines. In 1950s and 1960s, the most formative period of computer development, the costs of register and data transmission were considerably higher than now. Hence, the cost factors suggested as small a bit size per character as possible. (C. E. MacKenzie, 1980, pp.105-106).

4.2 ASCII and ISO 646

One of the earliest and the most successful character set standards was ASCII (American Standard Code for Information Interchange). It was developed by ASA (The American Standards Association) in 1963, and revised in 1967 into the current form. As a 7-bit code, it has 128 ($=2^7$) code points. Figure 4.1 shows the 8 x 16 ASCII table with each of 94 printable characters and 32 control characters (control functions characters are omitted in the figure) being matched with one of possible 128 varieties of 7-bit patterns. For example, a bit pattern of 1000001 is for 'A.' [5]

[5]The bits of the bit combinations of the 7-bit code are identified by b7, b6, b5, b4, b3, b2, and b1, where b7 is the highest-order, or the most- significant, bit and the b1 is the lowest order, or least-significant, bit' (European Computer Manufacturers Association 1991, p.3)

				b7	0	0	0	0	1	1	1	1
				b6	0	0	1	1	0	0	1	1
				b5	0	1	0	1	0	1	0	1
b4	b3	b2	b1		0	1	2	3	4	5	6	7
0	0	0	0	0			SP	0	@	P	`	p
0	0	0	1	1			!	1	A	Q	a	q
0	0	1	0	2			"	2	B	R	b	r
0	0	1	1	3			#	3	C	S	c	s
0	1	0	0	4			$	4	D	T	d	t
0	1	0	1	5			%	5	E	U	e	u
0	1	1	0	6			&	6	F	V	f	v
0	1	1	1	7			'	7	G	W	g	w
1	0	0	0	8			(	8	H	X	h	x
1	0	0	1	9			)	9	I	Y	i	y
1	0	1	0	10			*	:	J	Z	j	z
1	0	1	1	11			+	;	K	[	k	{
1	1	0	0	12			,	<	L	\	l	|
1	1	0	1	13			-	=	M	]	m	}
1	1	1	0	14			.	>	N	^	n	~
1	1	1	1	15			/	?	O	—	o	DEL

†Reproduction of table from ECMA-6, p.12.

Figure 4.1: ASCII

The main feature of ASCII is its 7-bit structure. The decision was a result of two stages of internal disputes within ASA in regard to the structure, between the advocates of 6-bit shifted code and 7-bit code, and then, between 7-bit and 8-bit code (C. E. MacKenzie, 1980).[6] First, when the standards committee surveyed graphic and control characters requirements, the response indicated that the new standard for computing and communication would need more than 64 characters. 64 was a significant figure, for it was the maximum codespace with 6-bit code ($64=2^6$) and many contemporary computers were based on the 6-bit architecture with 6 registers per a memory unit, while a new 8-bit architecture was emerging in the market. As a way to use more than 64 characters on the 6-bit architecture, the committee considered a shifted or precedence code. The shifted or precedence code allocates a different character to the same bit combination if it comes after a certain preceding shifting character, thus allowing

[6]The description of two disputes within ASA over ASCII structure here is heavily drawn from C. E. MacKenzie (1980) Coded character sets, history and development.

a larger character repertoire to be used than the number of permutations of a given bit length. The technique is analogous to the 'shift lock' used in mechanical typewriter.[7] However, the low reliability of the communications line of the time posed a serious risk in the dependability of the shifted code. At the time, it was not uncommon to have a phenomenon called 'hit' during communication which would turn a zero bit into 1, and 1 into zero. In many cases, it is reasonably simple to guess the original intention of the message. When it occurs to number, however, it is more difficult to guess its occurrence than in a letter in a word. Or, worse when the shifted character itself is hit, the meanings of a series of characters between the shifted character and the next one would be altered, causing grave confusion. Between the choice of the economic but unreliable 6-bit shifted code and more expensive but robust 7-bit code, the committee chose 7-bit code capable of 128 code points without shifting.

Second, when the possibility of 6-bit shifted code was dropped, there was an appeal for 8-bit code against the 7-bit code. Both 7-bit and 8-bit character sets were based on the new 8-bit computer architecture. IBM delivered IBM 7030, the first 8-bit architecture computer, for Los Alamos Scientific laboratory in 1961, and then it launched a hugely popular model, System/360 in 1964 with the 8-bit architecture. The basic idea behind the 8-bit architecture of IBM machines is 'packing' two numeric digits into one 8-bit byte. The representation of 10 decimal numbers needs only 4 bits, so the 6 or 7-bit representation would involve the waste of 2 or 3 bits per every piece of numeric data. Considering the importance of numeric data in the early 1960s, - it was estimated that roughly 75 percent of data processed was numeric data - the 8-bit character set with packing made a strong case. In the end, the argument for 7-bit code won over 8-bit code, for it was thought that first, 128 codespace from 7-bit combination would satisfy character requirements, second, 8-bit code would cost more for transmission, third, the 7-bit code would enable the use of a redundancy bit for error control called

[7] Same key strokes of a, b, and c would be A, B, and C when they are keyed in after the shift lock.

'parity check,'[8] which was compatible with contemporary one inch-perforated tape design.

	0	1	2	3	4	5	6	7
0			SP	0		P		p
1			!	1	A	Q	a	q
2			"	2	B	R	b	r
3			#	3	C	S	c	s
4			$	4	D	T	d	t
5			%	5	E	U	e	u
6			&	6	F	V	f	v
7			'	7	G	W	g	w
8			(	8	H	X	h	x
9			)	9	I	Y	i	y
10			*	:	J	Z	j	z
11			+	;	K		k	
12			,	<	L		l	
13			-	=	M		m	
14			.	>	N		N	
15			/	?	O	—	o	DEL

	0	1	2	3	4	5	6	7
0			SP	0	@	P	`	p
1			!	1	A	Q	a	q
2			"	2	B	R	b	r
3			#	3	C	S	c	s
4			$	4	D	T	d	t
5			%	5	E	U	e	u
6			&	6	F	V	f	v
7			'	7	G	W	g	w
8			(	8	H	X	h	x
9			)	9	I	Y	i	y
10			*	:	J	Z	j	z
11			+	;	K	[	k	{
12			,	<	L	\	l	|
13			-	=	M	]	m	}
14			.	>	N	^	N	~
15			/	?	O	—	o	DEL

†Reproduction of table from ECMA-6, pp.11-12.

Figure 4.2: ECMA-6 and ISO 646 (IRV of ECMA)

ASCII was soon widely accepted as a standard by most of the U.S. manufacturers apart from IBM which opted for its own proprietary 8-bit code, EBCDIC (Extended Binary Coded Decimal Information Code). The success of ASCII in U.S. and the dominance of U.S. computer manufacturers in world market helped it to be accepted as a model for international standards. In 1965, the European Computer Manufacturers Association (ECMA) accepted the ASCII as its standard, ECMA-6. However, ECMA made provisions for flexibility by leaving 10 code points available for national and application-oriented requirements. National standardization bodies or interested parties could exercise the options according to their special requirements. ECMA also provided a default version,

[8]Parity check (odd-even check) is 'the computation, or re-computation for verification, of a parity bit to determine if a prescribed parity condition is present' (Oxford dictionary of Computing, p.357).

International Reference Version (IRV), for where there were no such extra requirements. Figure 4.2 shows the ECMA-6 and ISO 646 with the locations of 10 options code points in greyed boxes.[9] The international organisation for standardization (ISO) also acknowledged the IRV as the ISO recommendation 646 in 1972, effectively establishing the first round of international character set standards regime based on ASCII. For example, national variants, British BS 4730, French NF Z 62-010, German DIN 66003, and Korean KS C 5636, were designed under the rules, and identified as ISO-646-UK, ISO-646-FR, ISO-646-DE, ISO-646-KR respectively.

4.3 ISO 2022 Extension Techniques

Even though the ISO 646 was widely adopted, the structural limitation of the 7-bit code soon became evident. First, even though the flexibility provision of 10 code points was useful for national variants, it also became an obstacle for a seamless exchange of data across borders. The existence of national variants utilising the same codespace created a risk of data corruption. Moreover, non-Latin based scripts, such as, Greek, Cyrillic, Arabic, and Hebrew could not be comprehensively included within the rules of ISO 646. Also, some nations have scripts with simply too large a repertoire to be covered within the capacity of 7-bit structure of ISO 646. China, Japan, and Korea, for example, use thousands of ideographs and varying numbers of national phonetic characters. Growing international integration required an improved means of international information exchange, and ISO 646 appeared to be a solution of limited application. Responding to the problems, the ISO devised ISO 2022 extension techniques, a set of rules for extending codespace beyond the remit of ISO 646 in two different methods. First, ISO 2022 stipulates the rule for extending ISO 646 code into an 8-bit encoding scheme, which allows additional 128 code points with the grand total of

[9]ECMA-6 was revised in 1967, 1970, and 1973. IRV was introduced in the third version.

256 code points. The alternative is a more radical double-byte extension: encoding a character with double byte stream. Breaking the barrier of one byte per character, the double-byte extension could potentially open 65,536 code points. The two extension techniques were designed under different structures and for different types of scripts in minds.

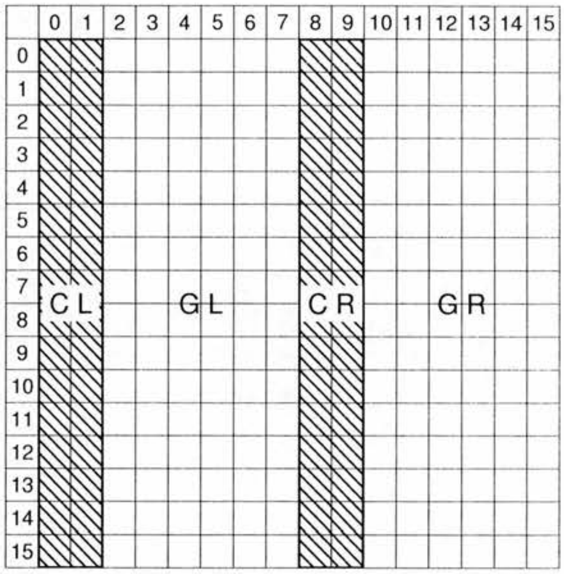

Figure 4.3: ISO 2022: 8-bit extension

First, the 8-bit extension is based on the same one-byte one character principle as ASCII and ISO 646, and it was designed for various phonetic scripts with relatively small size of repertoire. A central guideline for the 8-bit extension is the use of common code elements[10] for both 8-bit and 7-bit character sets.

> The code elements used in the structure are common to both the 8-bit and 7-bit codes. …… The use of common elements in the 8-bit and 7-bit code structure enables any specific conforming 8-bit code to be transformed into an equivalent 7-bit code, and vice versa, in a simple and direct fashion (European Computer Manufacturers Association 1994, p.1).

[10]'Character-set code element shall be an identified set of coded graphic characters, or of coded control functions (or characters), together with an element name to indicate the relationship of the set to the structure of the code' (European Computer Manufacturers Association 1994, p.13)

Therefore, the structure of 8-bit extension was designed in a way that the extended area by an extra bit has a mirror image of 7-bit code, hence, a 8-bit code is equivalent of having two 7-bit codespace with two sets of control functions areas, CL (Control Left) and CR (Control Right), and graphic characters areas, GL (Graphic Left) and GR (Graphic Right), as shown in Firgure 4.3. In this way, one of the common code elements could be invoked[11] into either GL area under a 7-bit environment. Alternatively, any two sets of code elements can be invoked at the same time each into GL and GR area under the 8-bit environment, enabling to use twice as large a repertoire as ASCII or ISO 646.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0			SP	0	@	P	`	p			NBS	°	À	Đ	à	ð
1			!	1	A	Q	a	q			¡	±	Á	Ñ	á	ñ
2			"	2	B	R	b	r			¢	²	Â	Ò	â	ò
3			#	3	C	S	c	s			£	³	Ã	Ó	ã	ó
4			$	4	D	T	d	t			¤	´	Ä	Ô	ä	ô
5			%	5	E	U	e	u			¥	µ	Å	Õ	å	õ
6			&	6	F	V	f	v			¦	¶	Æ	Ö	æ	ö
7			'	7	G	W	g	w			§	·	Ç	×	ç	÷
8			(	8	H	X	h	x			¨	¸	È	Ø	è	ø
9			)	9	I	Y	i	y			©	¹	É	Ù	é	ù
10			*	:	J	Z	j	z			ª	º	Ê	Ú	ê	ú
11			+	;	K	[	k	{			«	»	Ë	Û	ë	û
12			,	<	L	\	l	|			¬	¼	Ì	Ü	ì	ü
13			-	=	M	]	m	}			SBY	½	Í	Ý	í	ý
14			.	>	N	^	N	~			®	¾	Î	Þ	î	þ
15			/	?	O	_	o	DEL			¯	¿	Ï	ß	ï	ÿ

Figure 4.4: ISO 8859-1 (Latin 1)

ISO 2022 established only the rules for 8-bit code structure and left implementation to the future, according to the national or regional needs. The ISO 8859 is the most successful and widely used implementation of the ISO 2022 8-bit extension technique. As a series of ASCII supported characters sets, the GL area of ISO 8859 is used to invoke ASCII, and the GR area is to invoke one

[11] To invoke is 'to cause a designated set of characters to be represented by the prescribed bit combinations whenever those bit combinations occur'(European Computer Manufacturers Association 1994, p.5).

of several collections of national requirements in certain targeted regions. Figure 4.4 shows the 16 by 16 table of ISO 8859-1, an implementation of the 8-bit extension technique, also known as 'Latin-1.' The first to eighth column, the GL area, remained same as the ASCII, but the extended graphic character area (GR) has a collection of commonly used characters and symbols in Western European countries outside the boundary of ASCII. By incorporating the new repertoire in the extended area, ISO 8859-1 can guarantee a frictionless information exchange among many languages, such as Albanian, Basque, Catalan, Danish, Dutch, English, Faroese, Finnish, French, German, Icelandic, Irish, Italian, Norwegian, Portuguese, Rhaeto-Romanic, Scottish, Spanish, and Swedish. There are other implementations of ISO 8859, catering for specific regional needs, such as ISO 8859-2 (Latin-2) for Eastern European countries, ISO 8859-3 (Latin-3) for Southern European countries, ISO 8859-4 (Latin-4) for Northern European countries, ISO 8859-5 (Cyrillic), ISO 8859-1 (Arabic), ISO 8859-1 (Greek), ISO 8859-1 (Hebrew), ISO 8859-1 (Latin-5/Turkish), ISO 8859-1 (Latin-6/Nordic).

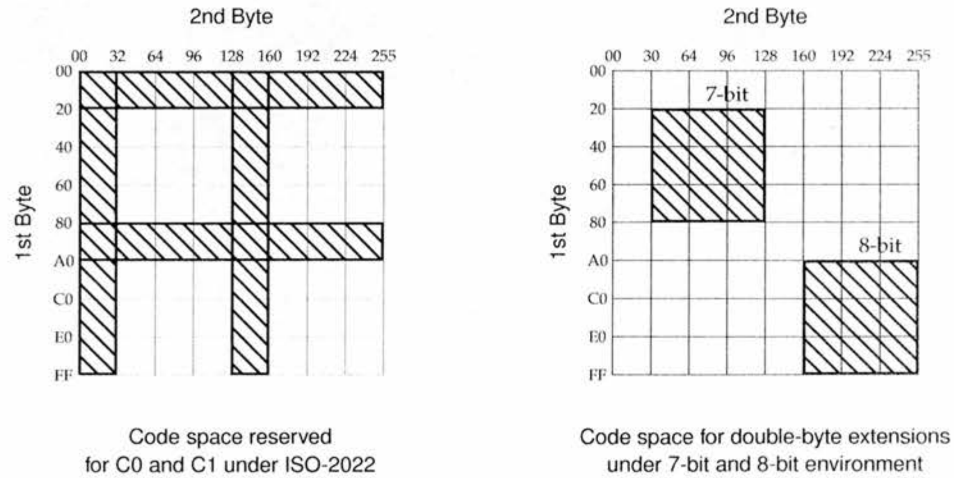

Figure 4.5: Structure of ISO-2022 double-byte extension rules

The second extension technique under ISO 2022 is based on a new principle of two byte streams per character. Its main target scripts are national scripts with larger repertoires than the ones covered by the 8-bit extension. China, Japan, and Korea, for example, use a combination of ideograph and phonetic characters,[12] the repertoire of which amounts to tens of thousands.[13] For those scripts, even the substantial improvement of the 8-bit extension into 190 (94 + 96) code points is virtually meaningless. In order to enlarge codespace for those scripts with large repertoires, therefore, the double-byte code uses a two-byte stream to encode one character. Depending on whether it is under 7-bit or 8-bit environments, the double-byte extension scheme has a code table of either 128 by 128 or 256 by 256. Thus, theoretically, this could open up a codespace of 16,384 ($=2^{14}$) or 65,536 ($=2^{16}$) shown in the Figure 4.5.[14] However, the major design principle of ISO 2022, the use of common code elements for both 8-bit and 7-bit character set, applied also to the double-byte extension techniques and imposed certain restrictions on the use of code points. In order to remain comparable to the 7-bit code structure, both control functions areas, CL and CR, were appropriated, eliminating the code points 1 to 32 from each byte under 7-bit environment and also 129 to 160 under 8-bit environment. Therefore, the codespace made by the application of ISO 2022 double-byte extension technique would be the multiplication of GL area (94 x 94) under 7-bit environment or the multiplication of GR area (94 x 94). The potential codespace of 16,384 (128 by 128) or 65,536 (256 by 256) was reduced to 8,836 (94 by 94) under both 7-bit and 8-bit environment.

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[12]China has Pinyin, Japan uses two sets of Kana, Korea has more than ten thousands of Hangul syllables, apart from the versions of Chinese ideographs which are called Hanzi, Kanji, and Hanza respectively in China, Japan and Korea.

[13]For example, the primary school curricula of China and Japan contain 2,500 Hanzi, and 1,006 Kanji respectively, and the repertoire increases during the course of secondary schools and further education.

[14]Notational convention of these standards documents use hexadecimal rather than decimal to describe the 256 by 256 tables. However, here and henceforth both hexadecimal and decimal notations are used together for 1st and 2nd byte respectively in order to make the table more accessible.

Despite the limitation, ISO 2022 laid an important foundation for the development of internationally compatible double-byte character set standard. Soon national standardisation bodies followed the lead of ISO and drafted double-byte national standard character sets, such as JIS C 62226:1978, GB 2312-80, KS C 5601:1987 The first one was JIS C 6226: 1978, a Japanese industrial standard. The significance of this standard was that it was the first national character set standard to include Chinese characters and also the first one to break the one-byte-equals-one-character barrier. Utilising the newly opened double-byte codespace, it was a kind of multilingual character set, containing symbols, numbers, Greek, Cyrillic and other Latin base alphabets, Japanese Hiragana and Katakana, line-drawing elements, and 6,359 Chinese characters which are divided into 2,965 level 1 kanji, and 3,384 level 2 kanji (Lunde 1999).

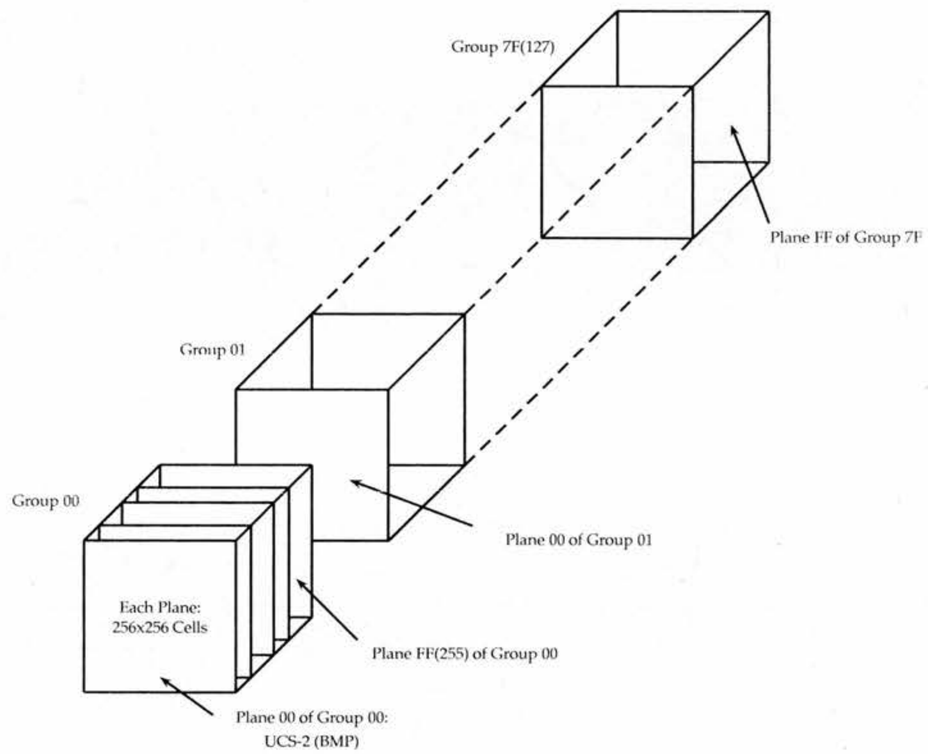
The JIS C 6226 provided a model for Chinese, Korean, and Taiwanese national standards. GB 2312-80 was established by the People's Republic of China, enumerating symbols, numbers, ASCII, Japanese Hiragana and Katakana, Greek and Cyrillic characters, Pinyin, Zhuyin, and 6,763 hanzi (3,755 level 1 hanzi, 3,008 level 2 hanzi), a total of 7,445 characters. It was followed by KSC 5601:1987, the Korean national standard, with 276 symbols, digits in both Arabic and Roman forms, the Korean alphabets, Latin letters A-Z and a-z with additional 27 letters, Greek, and Cyrillic letters, and 68 line drawing characters, Japanese Hiragana and Katakana, 2,350 Korean Hangul syllables, 4,888 Chinese characters. These national character set standards are remarkable improvements from the ASCII, incorporating thousands of characters and achieving selective multilingual capacity. However, the reduction of codespace caused by the restrictive ISO 2022 rules inevitably caused a degree of codespace shortage and resulted in either the omission of some national script repertoire or use of cumbersome complementary character sets in all three countries above mentioned.

4.4 ISO 10646 and Unicode

Apart from the code point shortage for those large repertoire scripts, ISO 2022 has another weakness, for the implementations of double-byte character set share the same code points for different national characters. The national scripts of China, Japan, and Korea share the same code points in the double-byte character set scheme under ISO 2022. They are only distinguished by the identifying signals preceding actual textual data, and this had been a source of confusion and data corruption in international information exchange and multilingual text processing. As international information transactions were increasing in a rapidly globalising political, cultural, and business environment, the demands for more stable and efficient media was also heightened. Also, rapid improvement of hardware capacity opened the possibility of larger units of information processing with relatively lower economic costs and less technological costs. Another incentive was the multinational software companies' desire to formulate a universal character set in order to meet the demands of a global market without the high cost of developing multiple localised versions with different national character sets.

From the mid 1980s, formal international standards organisations, first ISO and then, ISO/IEC JTC1 have been developing the Universal Multiple-Octet Coded Character set (UCS). The original blue print was to develop a four octet (32-bit) character set with more than 2 billion code points enough to incorporate all written characters ever devised in human history. Referring to the four-bytes-one-character structure, this is called UCS-4. Figure 4.6 shows the entire coding space of the UCS-4. However, its grand design requires four times as more resource as ASCII and twice as much as the double-byte character set under ISO 2022 for coding the same amount of data. This has been preventing the UCS-4 from being taken seriously by industry and national standardisation bodies.

However, the UCS included a concept of the Basic Multilingual Plane (BMP) within the structure of UCS-4. In addition to the 'four-octet canonical form,' UCS



†A reproduction of figure from ISO/IEC 10646-1 2nd edition, Draft 2. p.5.

Figure 4.6: Entire coding space of the UCS-4

prepared a 'two-octet BMP form' as a first step towards UCS-4. The idea of 16-bit character set was also supported by industry whose independent efforts began to consolidate with the foundation of Unicode consortium in 1991. Continuing cooperation between the ISO/IEC JTC1 and Unicode consortium produced two separate but synchronised 16-bit character set standards, ISO/IEC 10646-1 and Unicode. Figure 4.7 illustrates the structure of ISO/IEC 10646-1:1993 BMP which is identical to Unicode 1.1. This new generation of character set constitutes a fundamental shift from the previous standards in the sense that the requirement of structural compatibility with the 7-bit code, the main reasons for stringent code space limitation of the ISO 2022, was finally dropped, so it could utilise the whole 65,536 code points made available with two bytes. After the 7-bit standard of ASCII and the 8-bit or double-byte extension of ISO 2022, the third

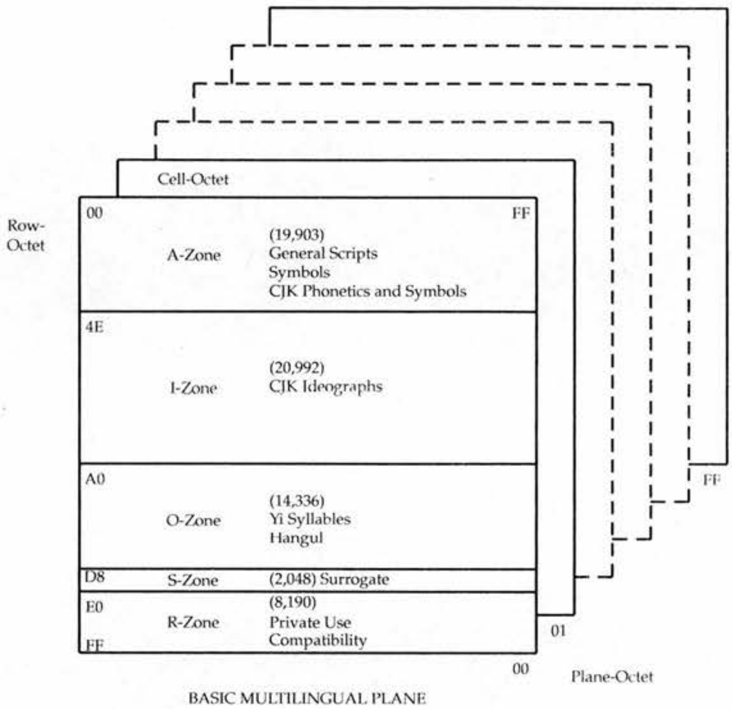


Figure 4.7: ISO/IEC 10646-1:1993 Basic Multilingual Plane

generation of international standard ISO/IEC 10646-1 and Unicode opened up the code space of 65,536 ($=2^{16}$) without constraint from legacy standards.

4.5 Conclusion

One distinctive feature of international character set standardisation has been the dominance of U.S. and European countries from the early stage of computer technology and the cultural mark it left on basic hardware architecture and character set development. While the technical feasibility and costs have been featured as main considerations for the basic design choices on the computer architecture and the structure of character set, decisions on how many bits should constitute one data unit have been undoubtedly guided by the distinctive local application requirements of the character repertoire. In U.S., 26 Latin-based letters, Arabic numbers, and other commonly used symbols formed the basis of the character repertoire and this was incorporated into the first successful U.S. national character set standard, the 7-bit character set, ASCII (American Standards Code for Information Interchange) in 1963. Also European countries with similar character repertoires could easily adapt to the character sets based on ASCII, and this factor helped ASCII become a model for the first international character set standard, ISO 646, with long term implications for future development. Based on their common cultural backgrounds, the formation of the byte-oriented character set was accepted as more or less 'natural' solution in the US and many European countries.

Optimised to the Latin-based scripts, a common feature in its place of origin, the international standard, ISO 646, could not provide adequate solution to many non-Latin based scripts. Arabic, Cyrillic, Greek, and Hebrew, for example, could not be included in the 10 free code points allowed for national requirements under the ISO 646. Moreover, scripts with repertoire of thousands, such as, Chinese, Japanese, and Korean could not be supported even if all the code points of 7-bit character set is allowed to be used for a national script. The ISO 2022 extension technique emerged as new international standard in order to resolve the shortage of code space for these ideographs and radically different phonetic characters on the one hand, and the desire to maintain international compatibility at the same time. Both extension techniques under the ISO 2022 were widely accepted as basic structure of many national character set standardisation. However, the priority given to the 7-bit architecture of ASCII in the ISO-2022 extension techniques imposes significant constraints on the efficient usage of codespace for double-byte extension, which made ISO-2022 unsatisfactory solution for the national scripts of large repertoire, such as China, Japan, Korea.

The advent of ISO-10646 and Unicode marked a radical shift in the international standards regime. Still, there remained elements of bias for ASCII or byte-oriented character set in the third generation standards. For example, the first rows of Unicode or BMP of ISO/IEC 10646-1 are allocated to Latin-based scripts, so that the information processing of those ASCII and Latin-based character could be optimised with the use of UTF (Unicode Transformation Format). However, the change to the unrestrained use of whole 16-bit stream has shifted the focus of international character set standards from a management of multiple national standards to a multilingual standard, a truly international standard. Therefore, the half century of character set standards development shows the emergence of three generations of international character set standards regimes; the first generation of ASCII and ISO 646 with 7-bit structure optimised to Latin-based scripts, the second generation, ISO 2022 extended its codespace with the limited but more powerful 8-bit and double-byte extension techniques, and finally the third generation with more inclusive and comprehensive 16-bit standard.

Interestingly, however, there have been different modes of absorbing the three generations of international standards. In some locales and for some applications, ASCII and ISO 646 remained strong throughout the changes, and the implementation of new standards has been slow. Here, the five decades of information processing is characterised by relative stability and continuation rather than periodical changes in terms of character set standards. In other areas where the demands for large codespace have been strong, the advent of the newer, more powerful standards has been more closely followed. Korea is one of those locales where the changes in the international standard regime have meant significant transformations of the immediate environment for information processing. The next chapter introduces the Korean script, 'Hangul', and presents a brief history of Korean character encoding experiments, and the three different generations of Korean character sets developed under the changing international character standards regimes.

CHAPTER 5

Korean script and

Experiments with character encoding

In contrast to the U.S. and many European countries, neither national nor industry standard of Korean character set had emerged until the late 1980s in Korea. Two main factors had complicated the matter and delayed the standard setting process. First, the architecture of digital computers and the international character set standards regimes had been incompatible with the large repertoire of Korean writing system. As explained in the previous chapter, the ASCII and byte oriented international character set standards were partly based on the cultural requirements of its geographical origin. Later, the incompatibility between the two cultural requirements, a small set of Latin-based script and large repertoire of Korean writing system had resulted in severe lack of codespace for Korean character encoding. The second factor was a unique feature of Korean indigenous script, 'Hangul,' allowing two competing approaches to the Korean encoding. Hangul consists of 24 basic phonetic letters (called 'Jamo'),[1] but these are conjoined together to make a syllable unit (called 'Hangul syllable'). The conjoining writing arrangement was not unique itself,[2] but this became a source of confusion for character encoding in Korea, because each level of script was

[1] 'Ja' and 'mo' refer to consonant (character) and vowel (characters) respectively. As a collective noun, 'Jamo' is always used in singular.
[2] Other phonetic scripts such as, Arabic and Thai allow conjoining of basic characters for phoneme to form bigger units with distinctive shapes.

used as a basic unit of character encoding by competing character sets. Both factors, the incompatibility between the two local requirements, and the existence of two competing approaches in Korea character encoding, had contributed to the proliferation of Korean character encoding experiments at different layers, in different ways, with different character sets. The particular circumstances has prevented an early nation-wide consensus on Korean character set design from arising among developers and users for decades.

This chapter aims to provide with basic information of the Korean indigenous script, Hangul, to survey various efforts to incorporate Korean script in the world of computerised information processing and three generations of Korean character sets development. Section 5.1 first, gives a general introduction of Korean indigenous script, 'Hangul,' and its unique features, which later became sources of division in Korean character set design. Section 5.2 reviews a variety of solutions designed to enable Korean input/output in mainly personal computer environment. Different layers of personal computer architecture were targeted by hardware solutions, emulator solutions, and application solutions. Section 5.3 examines the three generations of Korean character sets, which had been developed to work with various Korean encoding systems explained in the section 5.2. The first generation of Korean character sets was developed mainly for the mainframes and 8-bit personal such as IBM mainframes and Apple computers. The second generation was marked by rivalry between the two double-byte character sets, called Wansung and Johap, competing for 16-bit IBM personal computer architecture. The third generation is a Korean subset of a new international character set standard ISO/IEC 10646-1 and Unicode.

5.1 Korean Script, 'Hangul'

Korean writing system consists of two main components. An indigenous phonetic character called 'Hangul' is the main element of modern Korean writing system. The other element is Chinese ideograph locally called 'Hanja.'[3] Chinese ideographs had been used for two thousand years since its importation from China as early as the beginning of the Common Era. For long, it had been a dominant[4] means of recording in Korea to be slowly replaced by Hangul since the invention of the new script in the 15th century. In regard to the character encoding, the main problem with the Chinese ideographs is its sheer size of repertoire. Generally adopted solution for this problem under ISO 2022 environment is to categorise the repertoire into several levels by their frequency of use, encode them in several character sets, and invoke each character set as needed. Despite the complexity of the system, the character encoding has not generated much controversy, for the concept of categorisation of the characters has been familiar a idea in the countries using Chinese characters, and also there was no feasible alternative. However, the situation with Hangul was different because there exist different ways of approaching encoding issue. The rest of this section explains the writing system of Hangul before going into a variety of technical solutions.

The indigenous Korean phonetic script is called 'Hangul'. Hangul was designed by a royal institute, 'Jip-Hyun-Jun (집현전/集賢殿),' under close supervision of the King, Sae-Jong, in 1443. After three years of test, the new script, originally named ' Hun-min-jeong-eum (훈민정음/訓民正音),'[5] was published in a book of the same title in 1446 in bilingual format, in the new script itself and Chinese. The design features of Hangul was marked by the local understanding of its native Korean language, but it was also influenced by the long standing historical tie with neighbouring China. First, in the 15th century, Chinese phonologists analysed a syllable into two different components, 'onset' (initial

[3]'Hanja' (한자) is Korean pronunciation of Hanzi (漢字) in Chinese.

[4]There have been a few other phonographic scripts coexisting with Chinese character in different historical period, but all of them were marginalized and lost.

[5]The meaning of the name is 'Right sound to teach people.' Since its publication, it has been called by many official and unofficial names, until the current official name 'Hangul' was widely used. The name 'Hangul' was given by one of the most prominent scholars in the field at the turn of the century, Si-Kyung Chu. It appeared for the first time in a children's magazine in 1913, and widely used after 1928 when it was used to name a memorial day for its creation.'

consonant) and 'rhyme.'[6] Having more significant variation of final consonants in syllable in Korean, however, Korean scholars understood that speech sound is made up of two different basic types of sounds, consonant and vowel, and a rhyme could be further divided into nucleus (vowel) and coda (final consonant) as shown in Figure 5.1.

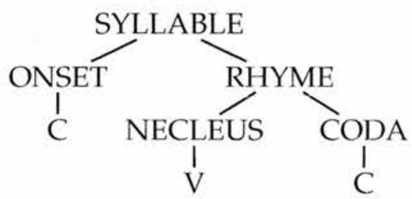


Figure 5.1: Structure of syllable

Therefore, when the royal institute set out for a new writing system, it devised a set of phonetic symbol, 'Jamo', for 17 consonants and 11 vowels[7] based on the spoken Korean at the time. However, the writing arrangement of the 'Hangul' bears the mark of early adoption of Chinese characters in Korea. Chinese is a monosyllabic language and its characters are ideographs. One result from the combination was that one ideographic character is pronounced in one syllable. Using Chinese characters for hundreds years, Korean scholars and literate aristocrats were very familiar with this idea, one character for one syllable. When the Korean design team stipulated the rules for writing, they decided to combine several 'Jamo' visually into a square display cell to form a syllable block, called 'Hangul syllable' so that each Hangul syllable of new script could match one-to-one with a Chinese character in form and in sound (Ahn 2002). Figure 5.2 shows how 'Jamo' are constructed into Hangul syllables with the example of word 'cocacola.' According to phonological studies of modern Korean, Hangul

[6] There are many indications that Chinese traditionally analysed a syllable into onset and rhyme. The most updated references of Chinese phonology available to Korean scholars at the time was, 'Hong-Wu-Zheng-Yun(洪武正韻),' published in 1375 under Ming dynasty.

[7] Three original consonants and a vowel symbols were dropped, so the modern grammar acknowledges 14 consonants and 10 vowels (Hangul Institute 1933).

syllables are made of 67 phonemes in three different constituent parts of a syllable: 19 onsets (or initial consonants), 21 nucleus (vowels), and 27 codas (final consonants). Therefore, the total number of potential composition of 'Jamo' into Hangul syllable is 11,172 (=19 x 21 x 28)[8] for modern Korean. Even though the constituent phonetic symbol, Jamo is the basic element of Korean writing system, the Hangul syllable is normally treated as a separate, and smallest unit, which is used both for measurement of document size and calligraphic rendering.

C O C A C O L A	: Coca Cola written in English
ㅋㅗ ㅋㅏ ㅋㅗ ㄹㅏ	: Equivalent in Korean phonetic element 'jamo'
可 口 可 樂	: Chinese
코 카 콜 라	: 'jamo' arranged in syllable block
CA LA	: English arranged in syllable block

Figure 5.2: An example of conjoining 'jamo' into syllable block

This unique feature of the 'Hangul' seems to have served the purpose of creating a new and easy national script, and it also satisfied the established perception of one-to-one match between a character and a syllable from the long use of Chinese characters. When Hangul became an object of character encoding in computers, however, the design features of Hangul allowed two major approaches, 'syllable encoding' and 'character encoding,' and a main source of division and controversy on character encoding issue. First, 'syllable encoding' approach recognises Hangul syllable as a basic unit of encoding, therefore, gives a code points to each Hangul syllable. However, the total number of Hangul syllable composition allowed under modern Korean grammar is 11,172. The size

[8]To constitute a syllable, the nucleus is a necessity, but both onset and coda can be missing. As the number of coda, 28 is used to count the all potential Hangul syllables with or without coda, but there is no change in the number of onset, because one of symbol used for onset is also used to indicate the absence of onset in a syllable.

of repertoire made it virtually impossible to be fully encoded under the international standard regime of ISO until the advent of 16-bit codes in 1990s.

Second, Hangul also allows an alternative approach to Korean text encoding, 'character encoding,' for Hangul is essentially made of phonetic characters, 'Jamo,' this could be a unit of encoding. There have been three major types of Korean encoding based on this approach so far. One way of character encoding is to encode each Jamo in 7-bit code or 8-bit code, and Hangul syllable is made of a stream of these 7-bit or 8-bit bytes.[9] Another way of character encoding is to divide double-byte code into three 5-bit sections and allocate each of them to one of three constituents of Jamo for a Hangul syllable. A combination of these three 5-bit sections and leading bit (MSB) constitutes a 16-bits code point of a Hangul syllable.[10] Another character encoding method was also adopted in the second level implementation of the ISO/IEC 10646-1 and Unicode. Here, a full 16-bit combination is given to each Jamo, and the composition into Hangul syllable is made up of a variable number of these 16-bit codes. The unique feature of Korean script, therefore, allowed the existence of parallel encoding schemes, which made different experiments possible, but also adversely affected national character set standardisation.

5.2 Korean experiments - solutions of different layers

In 1967, an IBM 1401[11] was imported as the first digital computer in Korea. Census Bureau acquired the machine to speed up the processing of the 1966 census results. Other government branches, financial institutes, corporate giants, and universities, soon began to use digital computers for large-scale data processing and education. However, early use of these computers involved a cumbersome process of translating data into English and re-printing results in Korean in printing shop, for the imported computers by default worked only with information

[9]Detailed explanation is in 3.2 First generation: N-byte and three-byte code.

[10]Detailed explanation of this approach is in the section 5.3.2.

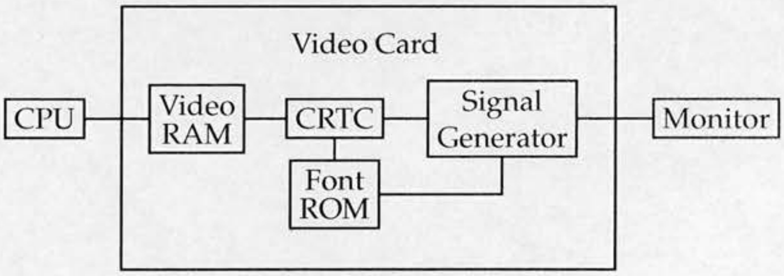
[11]Installation of the outdated IBM 1401 was provisional until the popular IBM System/370 was delivered at the end of 1968.

in English and majority of raw data included Korean text. It was evident that more efficient information processing needed a direct access to Korean textual data by a Korean input/output system. This was demonstrated by the fact that one of the earliest computer related government and industrial R & D projects was the Korean line-printer development. KIST (Korea Institute of Science and Technology) and IBM Korea independently developed Korean line printers in 1970 and 1971 respectively, and this improved the efficiency of Korean data processing and contributed to the success of early government-led computerisation projects, such as, the computerised management of nation-wide university entrance examination results, and the automatic telephone billing of long-distance and international calls (Seo 1997).

The development of Korean input/output systems in mainframe and mini-computers were not crucial for the adoption of the technology, because the organisational users of the equipment were equipped with expertise and in-house development capability. Korean encoding remained concerns of corporate users, providers of hardware and software, and research institutes. As microcomputers began to arrive at Korean consumer market in the late 1970s, however, adequate support for Korean input/output system became an important factor for efficient use and diffusion of the computers technology. Soon, importers and manufacturers of microcomputers, amateur programmers, software developers, as well as experts in government agencies began their search for the best Korean input/output system. From the late 1970s, a variety of solutions were devised and tried in the market, targeting different levels of microcomputer architecture: hardware devices were modified, dedicated programs and system software supports were written, and applications level input/output routines were developed. The rest of this section describes the basics of three main solutions for Korean input/output systems.

5.2.1 *Hardware solution*

In order to display information on monitor, microcomputer has a display adapter, a subsystem of computer that retains the image information to be shown on monitor. IBM PC series and its clones have the display adapter in a form of specialised circuitry on motherboard or a separate plug-in card connected through one of expansion slots in motherboard called 'video card,' or 'graphic card.' (Norton 1999, p.373). Early IBM PC was equipped with a graphic card called MDA (Monochrome Display Adaptor), capable of rendering 80 columns by 25 lines of characters, numbers, and symbols of ASCII on a green monochrome screen. Later versions of PC used different standards of graphic card in order to add colours or to improve resolutions, such as Hercules, CGA (Colour Graphic Adaptor), EGA (Enhanced Graphics Adaptor), VGA (Video Graphics Array), and Super VGA. Figure 5.3 shows a simplified structure of graphic card in PC. To summarise the mechanism, when a program writes certain signals of character set into certain addresses of video RAM in a video card, the display adapter matches it with a proper glyph in a font ROM, and generates resulting image on a specified position of character-cell of a monitor.



CRTC : Cathode Ray Tube Controller

†A reproduction of figure from Lee & Jung (1991, p.34)

Figure 5.3: A schematic illustration of PC Video card structure

Using this routine involved in this character rendering, a group of developers of Korean input/output systems devised a Korean-enabled graphic card, commonly called, 'Hangul card' which would replace a standard graphic card designed for original personal computer architecture. The Hangul card operates with a program called, 'Hangul automata'[12] which receives signals from peripheries, mainly from keyboard, and composes them into a Hangul syllable (sometimes as single Jamo as it is) and gives it appropriate character code. For output, Hangul card recognises the character codes for Korean script, and then matches them with Korean fonts in font ROM on the card, and generate Korean characters on monitor. This solution is commonly called, 'Hangul card solution' or 'Hardware solution,' for the altered graphic card is the core part of this Korean input/output system.

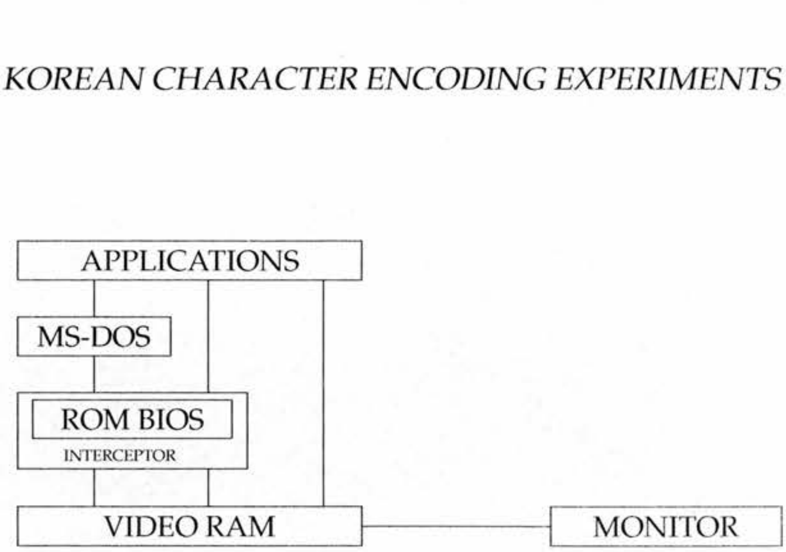
5.2.2 *Software solution (ROM BIOS intercept/ timer-tick interrupt)*

Whereas the 'Hangul card' offered a solution for the problem of Korean input/ output system with a specialised hardware installation, there also emerged other solutions operating at software level. Very popular with personal computer users was a two types of software solutions. While the Hangul card installation cost twice as much as the default ASCII based graphic card, the software solutions consist of cheap or freely available programs which enable Korean input/ output within unchanged personal computers configuration including the original ASCII-based graphic cards. Another feature of the software solutions is the use of graphic mode. In contrast to the Hangul card, these solutions render Korean script in graphic mode, that is, it renders character image pixel by pixel. There have been two types of software solutions based on different methods of intervention, first, a ROM BIOS intercept method, and the second, Timer-tick-interrupt method.

Well known example of the ROM BIOS intercept method is NKP,[13] a program developed by a Korean computer manufacturer, 'Sambo Computers,' and designed to work with the most popular Hercules display adapter and English

[12] It is installed either as a separate 'terminate and stay resident program (TSR),' or as a part of MS-DOS Korean versions.

[13] Sambo Computers originally provided users with a program, HP.com which was replaced by more advanced CHP and then again by NKP. Later, other versions NKP were also developed for the VGA card or special laptop graphic cards.

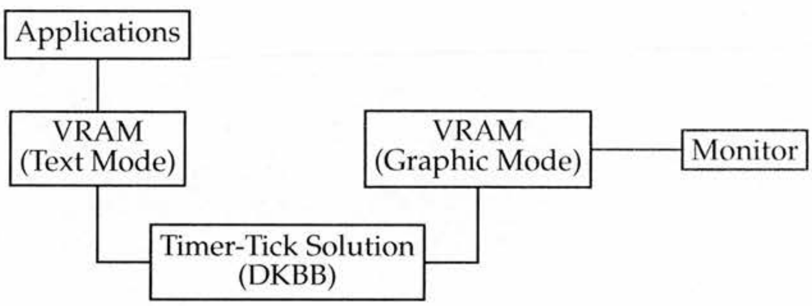


†A modification of figure used in Lee & Jung (1991, p.39)

Figure 5.4: ROM BIOS interceptor and the channels of access to video RAM

version MS-DOS. The NKP processes the Korean script by intercepting signals to and from the ROM BIOS. When there is a Keyboard input signal, it runs the 'Hangul automata' to allocate a proper code point for the Korean script and hand in the code to operating system. For the output on monitor, the NKP intercepts the output signal to text mode video RAM, and render the font image of desired character on the screen under the graphics mode. Offering a easy and cheap solution on the Hercules card, the NKP became a big success. However, the ROM BIOS intercept solution was not without weaknesses. First, it was much slower than the hardware solution under the processing power of microcomputer of the 1980s. Second, it could not be used with applications that directly access the video RAM. As the figure 5.4 shows, different applications choose different channels to finally access the Video RAM, and for this reason, the NKP does not function with applications that bypass the BIOS for input/output routines. For example, Lotus 1-2-3, one of the best selling PC applications of the time, directly accesses the Video RAM, and the NKP was of no use for the application.

A response to this problem was the timer-tick interrupt solution. Timer-tick interrupt is one of interrupt mechanisms IBM PC uses for various purposes. A timer causes interrupts at regular interval, 18.2 times per second. When there is a task coordinated with the interrupt, the processor suspends a current task and execute the designated task with interrupt, and then returns to the original instruction. The timer-tick interrupt solution uses this periodically repeated interrupts in order to process Korean script. Whenever timer-tick interrupts occur, it reads data from the text mode video RAM, and then draw appropriate images in video mode RAM. For this solution is working at the level of Video RAM rather than BIOS, it was compatible with the ASCII based applications with direct access to Video RAM. Figure 5.5 shows the level at which the solution operates.



†A modification of figure used in Lee & Jung (1991, p.40)

Figure 5.5: Timer-Tick Solution: DKBB

Basic idea of this technique was developed by a Taiwanese company, ETEN[14] in order to use Chinese character in original IBM PC environment, but soon, Korean programmers adopted this technique to process the Korean script. The first of its kind was a program, 'DKBB,'[15]which was first developed by a journalist working for a Monthly computer magazine, Microsoftware, and published at the magazine as a freeware on April 1989. Not only the program was freely distributed, but also its source code was made public, contributing to the development of modified versions with various improvements. A program called 'DKBY'[16] was the most famous modification based on the source code, resolving

[14]ETEN Information Systems developed the first Chinese Language Input System for DOS-based computers.

[15]The developer of DKBB, Chul-Young Choi, later commercialised the improved package with font ROM card, called 'Hangul Tokkaeby III'.

[16]The DKBY was developed by an amateur programmer, Wang-Sung Yang, who later turned into a professional.

the clashes with line-characters in the DKBB and restrictions on keyboard layouts. Later, the DKBY also developed into a communication solution, 'DKBX,' and a VGA supported version, 'VDKBY.' Also, its popularity helped other developers produce various commercial versions[17] of superior functionality.

5.2.3 *Applications solution*

Hardware and other software solutions had certainly contributed to the diffusion of personal computers in Korea by providing essential functions lacking in the original architecture of IBM PC. However, both approaches have a fundamental problem of compatibility. With regard to the hardware solution, almost every Korean computer manufacturers of substantial size had incorporated its own proprietary character sets in their solutions. Also, the performance of software solutions was not consistent across different types of character set, or models of display adapter. One of the consequences of these experiments was the chaotic proliferation of Korean input/output processing environment, which severely damaged the possibility of efficient Korean data processing and exchange. Moreover, the situation became an obstacle for the development of nascent Korean software industry. To write a Korean application, software developers either had to make multiple versions for each manufacturer with substantial increase in development costs, or write one program optimised to the specific setting of one system with further reduction of the already small applications market base of the product.

During the period of experimentation, Korean software developers began to try a radically different approach. The idea was to build an application that would include all necessary input output routines within itself so that it could process Korean data without resorting to the support of specialised hardware installation or other programs. The application of this kind recognises the Korean input signal, and assigns code points according to given Korean character

[17] Some of them remains purely software solutions, but others improved its speed and Chinese character support with a special font ROM card.

set. For the output of data, it draws the images of Korean script graphically using various fonts also included within the application. Applications of this kind could work on any IBM PC compatible with or without extra hardware or software installation for Korean data. The concept of Korean-enabled application was well received in the field of word-processor and communication emulators, for both fields required stable and consistent input/output system for more demanding and frequent editing and communication.

Pioneers of the applications solution came from word-processor program. 'Hangul-Word'[18] by Hahn Computer Institute in Toronto, Canada and 'Barungul' by Hyundai Electronics in 1986 were the first of this kind. However, those early programs had too limited a capability to have any impact on word-processor market. In 1988, Hahn computer institute moved its base to Korea and launched a new word-processor, 'Hangul 2000,' which became a first successful word-processor capable of Korean data processing within itself. Then in 1989, a group of amateur programmers[19] developed a Korean word-processor, 'HWP,' and it quickly became a best-selling word-processor in Korea (Lee & Jung 1991, pp.42-43).

The communication emulator market is another area where the application solution of Korean processing was favoured. For the main objective of the communication emulator is exchanging data on-line with other computer users, the general performance of the program largely depends on its capacity to deals with different Korean input/output systems. The emulator should work consistently regardless of the Korean processing mechanism of both the computer it is operating and the computer it was communicating with. By having their own Korean input/output routines within the applications it could achieve the stability in

[18] It was developed to be provided to an American company for high-performance terminals, Tele-Video, Inc., founded by a Korean-American

[19] Chan-Jin Lee, Won-Sik Lee, Hyung-Jip Kim, and Taek-Jin Kim were then university students acquainted with each others in engineering faculty and computer society of Seoul National University.

exchange of Korean data across different configurations of Korean input/output systems.

However, there were some shortcomings with the applications-level solutions. First, applications of this type were difficult and expensive to write and upgrade, than other applications without internal input/output routines. Unable to exploit the supports from BIOS and system software, programmers have to put extra time and energy for creating and amending those routines, which are normally outside of applications responsibility. Second, working with graphic mode was slower than with text mode. In particular, under the processing power of the late 1980s and the early 1990s, this was more restraining than it might be today. Later, the rapid increase in the processing power of microprocessor and size of RAM alleviated the problem of slow speed. However, as the Graphic User Interface (GUI) became common for personal computer ranges and the Input/output routines of system software became more complicated, the burden of maintaining internal libraries became more problematic for the application solutions than did the problem of speed.

5.3 Korean Coded Character Set

So far, the description of various Korean I/O (Input/ Output) systems focused on various ways of dealing with Korean encoding in microcomputer architecture without mentioning Korean character set used in those solution. For the character sets provide material data for Korean I/O system, the design of the two are closely related, however, the relation is not uniform. Sometimes, certain character set was designed to be fit into a specific design of Korean I/O system and vice versa. In many occasions, however, the relation is rather loose than one-to-one customisation of each other. Some Korean I/O systems are designed to utilise a variety of Korean character sets on the market. For example, 'Hangul

Tokkaeby III,'[20] supported three different Korean character sets, and also many Korean character sets were also designed for a general architecture, such as, the 8-bit or 16-bit microcomputer rather than for a specific Korean I/O system. Historically, there have been scores of Korean character sets vying for de factor standard status. The aim of this section is to introduce the development of different types of Korean character sets. The Korean character set could be classified according to several variables, such as, the number of bit for a byte (7-bit or 8-bit), the number of bytes for each Hangul syllable (N-byte, two-byte, three-byte), and the unit of encoding (character encoding or syllable encoding). Here, the review is guided by a combination of these criteria to show the historical development of Korean character set roughly in three generations.

5.3.1 *First generation: N-byte and three-byte code.*

N-byte character set is one of the earliest Korean character sets which began its life with mainframe computers imported in the 1970s. Also a class of personal computers, 8-bit Apple computer and MSX series used versions of N-byte character sets. There were two broad variants, the first variant allocates one byte to each basic Jamo. Because Hangul syllable sometimes includes consonants cluster and diphthong, the use of compound Jamo makes the byte length of one Hangul syllable varies from two to five bytes. The second variant divided a syllable block into three constituent parts - initial consonant (onset), vowel (nucleus), and final consonant (coda) - and allocate a byte to each of these three parts, whether it's a single basic Jamo or compound ones for diphthong and consonant cluster. Because Hangul syllable could be made without coda,[21] the variation of byte length

[20] A mixture of software solution and hardware support, developed by the creator of original DKBB, Chul-Yong Choi, it has a font ROM and program in a plug-in card. Marketed on July 1990, it became one of the most popular solutions for the cheap IBM PC clones assembled and sold by small-scale retailers in Chung-Gae-Chun and Yong-San arcades.

[21] A syllable also stands without both onset and coda, but in Hangul, the absent onset is marked with a consonant letter 'ㅇ' with mute sound.

for this variant is two to three bytes. The name 'N-byte' comes from the mathematical notation 'N' for a numerical variable in order to indicate that the byte-length for each Hangul syllable is not fixed. The N-byte code was 7-bit code and compatible with ASCII environment. ASCII code value is used to encode Korean as well as English characters. In order to signal the change between ASCII and Korean script, SO(Shift Out: ASCII code 14) and SI(Shift In: ASCII code 15) mark the start and end points of Korean script. Figure 5.6 shows the structure of N-byte with the examples of two Hangul syllable 가 and 김.

Hangul Syllable	Constituent jamo & Matching with ASCII		No.of Byte.	In ASCII with Marker	Byte streams with Markers
가	jamo	ㄱ + ㅏ	2	SO A b SI	0001101 1000001 1100010 0001111
	ASCII	A + B			
김	jamo	ㄱ + ㅣ + ㅁ	3	SO A | Q SI	0001101 1000001 1111100 1010001 0001111
	ASCII	A + | + Q			

Figure 5.6: Structure of N-byte code with examples.

Despite the pioneering role in Korean text processing in the 1970s and the early 1980s, the variable length of N-byte codes proved to be inhibiting due to the difficulties involved with editing. In order to identify a Hangul syllable among continuous byte streams, a program should search start and end point of Korean script and check surrounding bytes. There is also a problem of sorting, for the byte stream does not indicate whether a consonant is the coda of previous Hangul syllable or the onset of the next, which is an important factor for Korean character sorting.

Hangul Syllable	Constituent jamo & Matching with ASCII		No.of Byte.	In ASCII with Marker	Byte streams with Markers
가	jamo	ㄱ + ㅏ + fill	3	SO A b @ SI	0001101 1000001 1100010 1000000 0001111
	ASCII	A + B + @			
김	jamo	ㄱ + ㅣ + ㅁ	3	SO A | Q SI	0001101 1000001 1111100 1010001 0001111
	ASCII	A + | + Q			

Figure 5.7: Structure of three-byte code with examples.

Another Korean character set in the same generation was the three-byte code. It was similar to the second variant of N-byte code in that it allocates a byte for onset, nucleus, and coda rather than each basic Jamo. However, when a Hangul syllable lacks coda (final consonant), so-called 'fill code' is used to maintain the fixed length of three bytes per a Hangul syllable.[22] Figure 5.7 shows how the 'fill' is used to make the constant length of Hangul syllable in encoded byte steams. With the fill-code, the developers of three-byte code found the way of avoiding problem of the variable length code. Still SO and SI are used to mark the boundary between ASCII data and Korean script. However, this consistent three-byte allocation for Hangul syllable was an extra burden under limited memory and processing power of the time, for this consumes more resources, compared to a second variant of N-byte codes and the various double-byte character sets to be discussed below.

5.3.2 *Second generation: double-byte coded character sets.*

Despite the difference between N-byte and three-byte code, they both were based on 8-bit personal computer architecture, such as Apple II, or MSX computers. When the 16-bit architecture personal computer came into market with 16-bit length information processing, a double-byte character set became more attractive option for Korean script to exploit the advantage gained the hardware. The fixed length double byte character set allocates two-byte streams per one Hangul syllable. Implementation of the character set can be subdivided into three groups. First, the 7-bit double-byte character sets, and the second, two different types of 8-bit double-byte character sets, Johap and Wansung.

7-bit double byte character set was designed with a specific type of hardware in mind, so-called 'Chung-gae-chun card,' or Sae-un-sang-ga card,' named after the address and name of the famous electronics mall, Sae-un-sang-ga. The developers of this graphic card, engineer cum entrepreneurs operating in the mall,

[22] Also, the 'fill-code' is used when any of three constituent parts of syllable is missing, in order to represent grammatically incorrect occasions for educational purposes.

designed the hardware solution for IBM compatibles they sell. Primary concern of the developers was to run illegal copies of foreign software with Korean capabilities. For this reason, a 7-bit code was adopted to be compatible with the ASCII environment for which most of the foreign software was written, and a solution was needed to distinguish the ASCII characters and Korean character set without using the escape sequence or the 8th bit. Solution came from the idea that in English text, certain combinations of characters are very rare, such as, small letters followed by capital letters, small letters followed by special characters,[23] or two special characters in succession. The 7-bit double-byte character set assigned each of those unusual combinations of two ASCII characters to one Korean Hangul syllable. However, the total number of the rare combinations is around mere 1,400, far too small a number for 11,172 Hangul syllable even if the majority of the 11,172 is not frequently used in everyday language usage. Moreover, certain unusual combinations do occur more frequently for some unexpected reasons,[24] with unfortunate result for the character set.

In 8-bit double-byte character sets, all eight bits of a byte, including the Most Significant Bit (MSB),[25] are used for character encoding, and a two-byte stream is allocated to a Hangul syllable. Various implementations of the 8-bit double byte character set have been dominant form of Korean character set since the mid-1980s. Roughly, they can be grouped into two distinctive approaches of 'syllable encoding' and 'character encoding.' Main features of each approach are explained below.

The syllable encoding approach is called 'Wansung,' meaning 'precomposed' in Korean, for a range of code points is matched with a set of Hangul syllables which is already precomposed from Jamo and arranged in alphabetical order. Here, the target of coding is a unit of Hangul syllable rather than its constituent parts. Figure 5.8 shows the structure of Wansung. When the MSB of a byte is

[23] The special characters used in the card are _, ^, }, {, |, and ~.

[24] The name of a best selling database program, dBASE is a well-known example. ASCII character string, 'dBASE' is automatically changed into '늦ASE' by the Hangul card.

[25] The MSB is reserved for parity check in the 7-bit code.

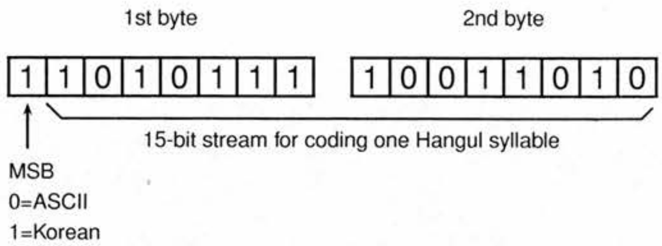


Figure 5.8: Structure of Wansung two-byte stream

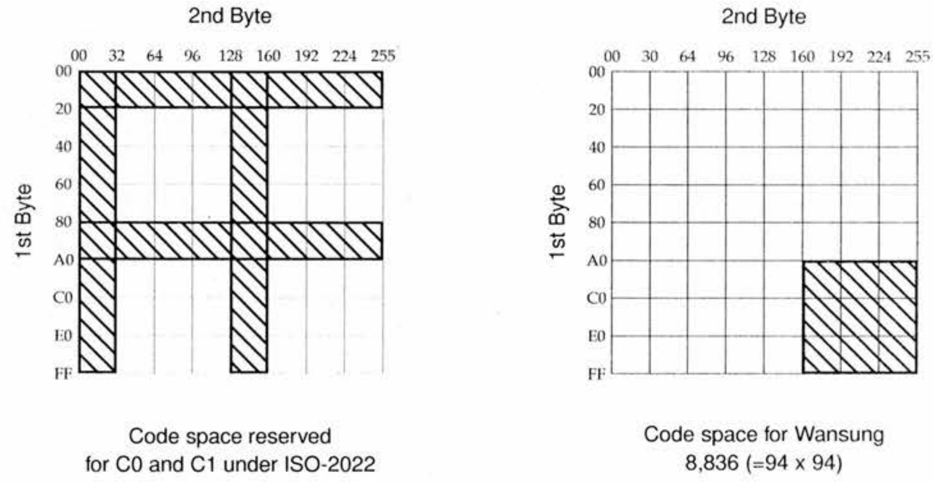


Figure 5.9: Code space of the Wansung character set

set 0, this indicates the byte in question is ASCII code. When it was set 1, this indicates that the following 15 bits are used for coding a Hangul syllable. Also, Wansung is an implementation of the international standard ISO-2022 extension techniques. Compliant to the ISO-2022 rules, the MSB of each byte is set to 1 for Korean character set, and the code space for the control functions C0 and C1 are reserved.[26] As a result, the codespace available for Korean character encoding is 8,836 (94x94), which is too small to encode all 11,172 modern Hangul syllables on

[26]See Figure 4.5 for codespace reserved for control functions and the double-byte character sets.

top of thousands of Chinese ideographs in use. Therefore, the designers of Wansung went through a selection process to select commonly used Hangul syllables among 11,172. KSC 5601:1987, one of the most widely used Wansung character sets, for example, incorporates 2,350 Hangul syllables, 4,888 Chinese characters, and other symbols. Figure 5.9 shows the code points it occupies among all potential code space of 256 by 256 table.

The character encoding approach, on the other hand, is called 'Johap,' meaning 'conjoining' in Korean. Rather than assigning code point to a selection of precomposed and alphabetically arranged Korean Hangul syllables, Johap approaches a Hangul syllable by its constituent parts. Johap divides the two-byte stream of total 16 bits into the first bit and rests of three groups of 5-bits. The role of the MSB is the same as Wansung, indicating whether the following bits are for the ASCII or Hangul, and the three 5-bit sections are used for each of three components of Hangul syllable, that is, onset, nucleus, and coda. Figure **??** shows the decomposition of a double-byte Johap character set into the four parts. In modern Korean grammar, the number of phonemes appearing on the positions of onset, nucleus, and coda of Hangul syllable is 19, 21, and 27 respectively. Each incidence of phonemes in three component of Hangul syllable is given one of 32 combinations made by each 5-bit section. Then, the code point of a resulting Hangul syllable is determined by adding up the three 5-bit sections and MSB, as shown in Table 5.4. There are also 'fill' for each section in order to represent individual Jamo, Hangul syllables without coda, and other uncompleted Hangul syllables. Unused bit patterns for Hangul syllable are used to code Chinese characters and other symbols.

Despite the difference in their approaches to Hangul syllable, Wansung and Johap, use two 8-bit bytes to encode a Hangul syllable. For Johap recognises the composition of Hangul syllable and retain the information within three 5-bit patterns, it is perceived to implement the 'character encoding approach' in comparison to the 'syllable encoding,' in Wansung. However, the actual full code

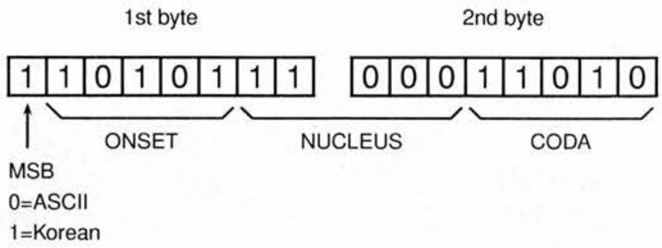


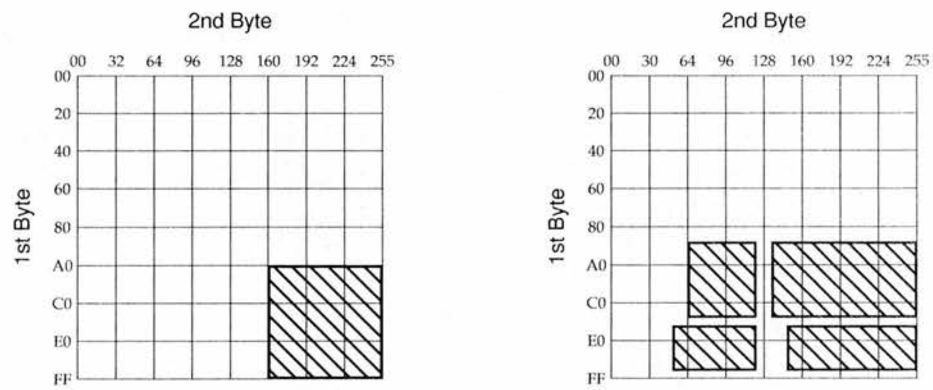
Figure 5.10: Structure of Johap two-byte stream

5-BIT PATTERN	ONSET (BITS 2-6)	NECLEUS(BITS 7-11)	CODA (BITS 12-16)
00000	unused	unused	unused
00001	'fill'	unused	'fill'
00010	ㄱ	'fill'	ㄱ
00011	ㄲ	ㅏ	ㄲ
00100	ㄴ	ㅐ	ㄳ
00101	ㄷ	ㅑ	ㄴ
00110	ㄸ	ㅒ	ㄵ
00111	ㄹ	ㅓ	ㄶ
01000	ㅁ	unused	ㄷ
01001	ㅂ	unused	ㄹ
01010	ㅃ	ㅔ	ㄺ
01011	ㅅ	ㅕ	ㄻ
01100	ㅆ	ㅖ	ㄼ
01101	ㅇ	ㅗ	ㄽ
01110	ㅈ	ㅘ	ㄾ
01111	ㅉ	ㅙ	ㄿ
10000	ㅊ	unused	ㅀ
10001	ㅋ	unused	ㅁ
10010	ㅌ	ㅚ	unused
10011	ㅍ	ㅛ	ㅂ
10100	ㅎ	ㅜ	ㅄ
10101	unused	ㅝ	ㅅ
10110	unused	ㅞ	ㅆ
10111	unused	ㅟ	ㅇ
11000	unused	unused	ㅈ
11001	unused	unused	ㅊ
11010	unused	ㅠ	ㅋ
11011	unused	ㅡ	ㅌ
11100	unused	ㅢ	ㅍ
11101	unused	ㅣ	ㅎ
11110	unused	unused	unused
11111	unused	unused	unused

HANGUL	BIT 1	BITS 2-6	BITS 7-11	BITS 12-16	BYTES STREAM
가	1	00010(ㄱ)	00011(ㅏ)	00001(fill)	10001000 01100001
김	1	00010(ㄱ)	11101(ㅣ)	10001(ㅁ)	10001011 10110001

Table 5.1: An example of Johap composition into Hangul syllable

points of two bytes are given to a Hangul syllable rather than each Jamo, and in that sense, both can be categorised in the same group, syllable encoding of Hangul syllable in double-byte. However, the difference in internal structure of Johap produces a significantly different result in terms of the code space it occupies. For Wansung character set, coding is a matching between a series of code points in certain area and precomposed Hangul syllable, it is possible to select some commonly used Hangul syllables from the whole repertoire of 11,172 and omit others according to the code space limitation. On the other hand, the code point of Johap depends on the automatic composition of three 5-bit patterns as shown in the Table 5.1. It is possible to omit a Jamo from the matching table between the Jamo and 5-bit patterns, but this would lead to an uncontrolled exclusion of a large number of Hangul syllables in the same way an omission of a letter in English dictionary would eliminate very large number of words from the dictionary. Simple selection from Hangul syllables is not possible for Johap. As a result, the adoption of Johap means that the full repertoire of 11,172 modern Hangul syllables are all included in the character set, but also it means an undesirable incursion into the reserved area under ISO-2022 extension rules. Table 5.5 compares the code space allowed by the ISO 2022 rules for a series of double byte character set, and the code space taken up by Johap.



Code space allowed under ISO 2022

Code space used by Johap

Figure 5.11: Comparison of codespace between ISO 2022 and Johap code space

5.3.3 *Third generation: 16-bit character sets*

As described in the last chapter, the advent of ISO/IEC 10646-1 and Unicode removed the restrictions on code points allocation under ISO 2022 rules and opened up the maximum codespace of 65,536 (256 x 256) created by the stream of two 8-bit bytes. With radical change in the international standards, Korean character set new standards. Even though the codespace of UCS-2 and Unicode was smaller than original blue print of four octet character set (UCS-4), the new standards could allocate unique code points to almost all national scripts in the world, and laid an important foundation for the truly internationalised character set standard and multilingual information process for the future. Realising the potential of the new international standards, the Korean representative, at private and public levels, actively involved in the design of the Basic Multilingual Plane of the ISO/IEC 10646-1 and the Unicode. As shown in the table 7.2, after a series of modification of Korean repertoire, all 11,172 modern Hangul syllables and 240 old and modern Jamo were included in BMP of ISO/IEC 10646-1:1995 and Unicode 2.0. In the same year, Korean government accepted the new 16-bit international character set as a national standard KSC 5700.[27]

Year	UCS/Unicode	Hangul Syllable		Hangul Jamo	
		Modern	Old	Jamo	Compatibility
1989	DP 10646	2,350			
1990	DIS-1 10646	2,350			
1991	Unicode 1.0	2,350			
1991	DIS-2 10646	4,280	1,673	94	
1993	IS 10646-1:1993	6,656	0	240	51
1993	Unicode 1.1	6,656	0	240	51
1995	IS 10646-1:1995	11,172	0	240	51
1995	Unicode 2.0	11,172	0	240	51

Table 5.2: Korean script repertoire in UCS and Unicode

[27] More detailed account of the activity of Korean representative and changing Korean repertoire is in Chapter 7.

Apart from temporary measure of compatibility Jamo, the new standard, KSC 5700 has two groups of Korean script for two different modes of encoding. First, it includes all 11,172 Hangul syllables alphabetical order, and gives each of them a 16-bit code point. It is an implementation of syllable encoding approach, similar to the 8-bit double byte character set, Wansung, but with no omission of Hangul syllables. Second, the KSC 5700 has a total number of 240 old and modern Jamo (consonant clusters and diphthongs are included), and allocates a 16-bit code point to each of these Jamo. The composition of these 240 Jamo could make all modern and old Korean syllables[28] in variable length code, according to composition of Hangul syllable in question. For this reason, this level of implementation of the KSC 5700 is perceived as a proper 'character encoding,' compared to Johap, which could be said an partial implementation of character encoding approach.

5.4 Conclusion

The Korean script, Hangul, is one of the most cherished cultural heritages ever celebrated in Korea. However, the incompatibility between the script and the imported digital computer caused a problem for processing Korean data. Reflecting the application requirements of the place of its origin, the personal computer architecture and the early character set standard was based on the 8-bit byte and English alphabet. Various Korean input/output systems were developed in order to process Korean text data directly, but with limited success in the 1970s. Real-time text processing was not a priority at the time, for the majority users of mainframes and minicomputers were large corporations and government organisations, and their typical need was the batch processing of formalised, mainly numerical data. When personal computer were imported, however, for the mass market in the mid-1980s, this became a more acute problem, for the success of

[28]The more relaxed grammar of the Old Korean permits large number of consonant clusters and diphthongs than modern grammar, and the representation of all possibility would require an addition of large number of Jamo. Therefore, the selection of 240 Jamo was based on actual appearance in historical records.

the personal computer was dependent on the mass market, and an adequate Korean input/output system was essential to persuade consumers to make the investment.

The newly opened mass market stimulated the development of Korean input/output systems under 16-bit personal computer architecture. Korean engineers devised four broad approaches, tinkering with different layers of computer architecture. Hardware solution is based on the installation of a modified graphic adaptor. Software solution is a group of TSR (Terminate and Stay Resident) programs which intercept and manipulate signals from and to ROM BIOS or VIDEO RAM for Korean input/output. Applications solution refers to a group of applications that is equipped with all necessary Korean input/output routines within themselves. The basic reason for these technological tinkering was the lack of the adequate Korean input/output support in imported BIOS and system software. Competition among those approaches continued until the more advanced Korean input/output routines were provided by the success of the Korean versions of Windows 3.1 and Windows 95. From then on, the localised system software became a dominant solution for the Korean input/output system, even though some applications retained its own routines.

In terms of the character set used by those various Korean I/O systems, there has been a myriad of Korean character sets that could be grouped into three different generations. The first generation Korean character sets were the variable length code and three-byte code, both of which give 7-bit code points to Jamo. The second generation includes three different types of double byte character sets, the 7-bit code and two 8-bit codes called, Wansung and Johap. The latter two were the main competitors for the national and market standard from the mid-1980s to the mid-1990s. The third generation Korean character set reflects the transformation of international character set standard regime, from the ISO 2022 to ISO/IEC 10646-1 and Unicode. The classification into the three generations of character set does not mean that the later generations replaced the earlier ones. The level of success of each generations of character set varies according to many factors, such as, the field of applications and the different cultural requirements of nations.

In contrast to other countries, the matter of this technical specification, in particular, the national standard setting of the Korean character set became a source of public controversy in several times from the late 1980s to the late 1990s. Based on the background information about the International and Korean character sets, the next three chapter will describe the controversy.

CHAPTER 6

Korean national standards controversy I :

1985-1992

Within the field of character set standards, there are many variations. Factors, such as, procedural rules, status of participants, voting system, legal status of implementation, and the range of coverage, all vary among different character sets standards, not to mention the degree of success of the standards in the market. There is huge difference, for example, between a proprietary company standard developed by a private company to serve its strategic objectives on the one hand, and an international standards set by a formal international standardisation body through a consensus building process among national representatives. Among the variety, the focal point of enquiry here is the level of national character set standardisation where government, national standard agency, voluntary standard organisation with similar authority design or acknowledge a character set as national standard. The national character set standardisation has been strategically important for character set standards for three main reasons. First, it is the nation state that constitutes, in many cases, a culturally coherent unit with a common language and script, and a politically and economically integrated society, where a strong demand for a common medium of information exchange, a standardised character set, would occur. Second, the growing demand for compatibility standards helped to strengthen the role of national standards body to control or supervises standardisation activities of many industrial fields, becoming a major producer of 'de jure' standards. Third, national standards agencies have, in many cases, enjoy the privilege of becoming a sole and legitimate representative of a state in the international standardisation organisations, in case of character set standardisation, currently ISO/IEC JTC1 SC2. These factors make the level of national standards a centre of domestic standardisation process and an important medium through which the domestic actors communicate with the actors at international level.

During almost three decades of Korean character set development, a series of national standards have assumed prominent roles. Although initial attempts of the Korean government had suffered failures in 1974 and 1982, the government became a central figure in the standardisation process with the success of the KSC 5601:1987. It functioned as an intermediary between the international standardisation activities to build an overarching compatible framework and the domestic standardisation strategies for nation wide information exchange. Since the late 1980s, the significance of the national standards began to attract the attention of various parties directly or indirectly affected by the standard, and the subsequent amendments of the KSC 5601:1987 in 1991 and 1992 became subject matter of social controversies.

Given the prominent status and wide ranging consequences of the national standard, it would not be surprising to find a competition between interested parties in the standard setting process. However, an interesting and unusual feature of the Korean character set development is that it has involved not only technical experts negotiating a viable technical standard in technical committees but also the wider public who had been normally kept away from the matter of technical specification of information technology. This chapter describes the first phase of the Korean national character set standardisation controversy between 1985 and 1992.

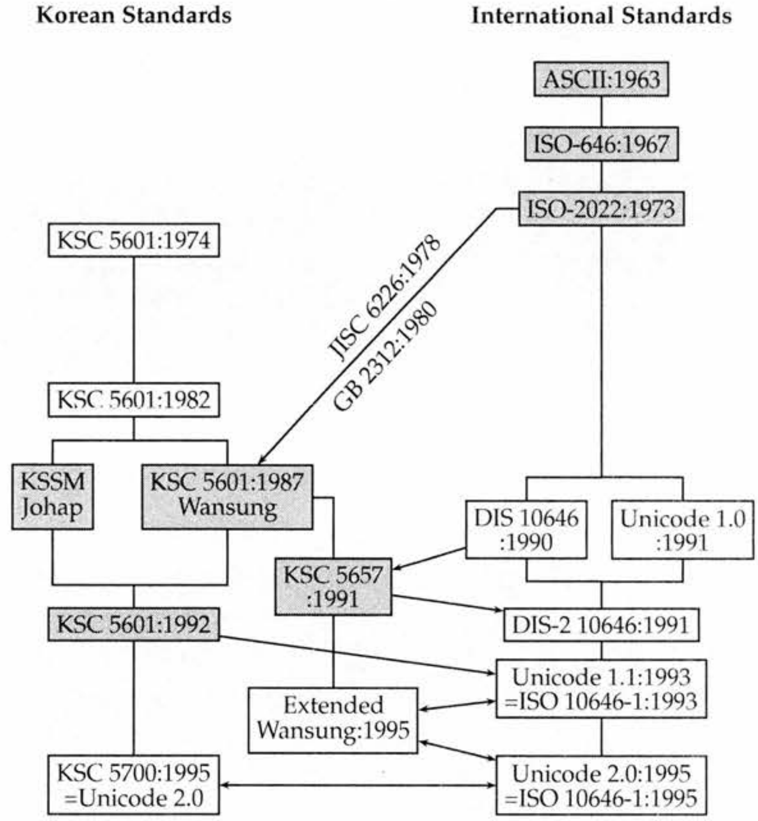


Figure 6.1: Korean and International Standards

Figure 6.1 shows the series of Korean and international character set standards that became the subject of controversy. In particular, the three international and four Korean standards in the shaded boxes are major foci in the first phase of controversy between 1985 and 1992. The international standards regime has set the backdrop of the generations of Korean standards setting, and the figure shows the lineage of each standard and its relation with others at both national and international level. At the international level, ASCII and ISO 646 set up a 7-bit character set environment for the character set standards for most Latin-based scripts. Then, ISO 2022 defined the standardised rules for internationally compatible double-byte code implementation, becoming the most direct inspiration for the national character set standardisation efforts of East-Asian countries, such as, China, Japan, and Korea. At the national level, four standards - KSSM,

KSC 5601:1987, KSC 5657:1991, KSC 5601:1992 - are at the centres of focus in this chapter. The KSSM (Johap) was emerging as a winner in the mid-1980s from chaotic competition among dozens of character set standards, until the government selected and promoted the other competing design, Wansung, as the national standard, 5601:1987. The new national standard was quickly accepted by industry thanks to the strong government backings. However, it was soon subjected to intense criticism for its inadequate support for Korean script, Hangul, and was amended in 1991 (KSC 5657:1991) and 1992 (KSC 5601:1992) as a result of growing public controversy.

The first phase of the controversy, as a whole, was dominated by the competition between two different character set types, Johap and Wansung represented by the KSSM and KSC 5601:1987 respectively. Johap and Wansung have contrasting advantages and disadvantages, satisfying the requirements of different user groups. The two most important requirements considered for a Korea national character set standard were the support for national script, 'Hangul' on the one hand and international compatibility on the other. Under the international standard framework of ISO 2022, however, these two requirements have an adverse relationship, that is, compliance to one requirement is only possible at the expense of the other. As the competition between two approaches continued through the latter half of the 1980s to the early 1990s, two warring camps had been formed to support each type of character set to be chosen for the Korean national standard. Figure 6.2 shows the briefs of two contending character set types, implementations, main features, and supporters.

This chapter summarises the period from 1985 to 1992, roughly the first half of the period of controversy. The main narrative of the first phase is that the Korean government, for the first time, successfully set up KS C 5601:1987, a Wansung standard, as a national standard from a chaotic market competition in the mid-1980s, and then it was then persuaded to amend the standard twice, first in 1991, as a result of dispute among experts, and second in 1992, under intense

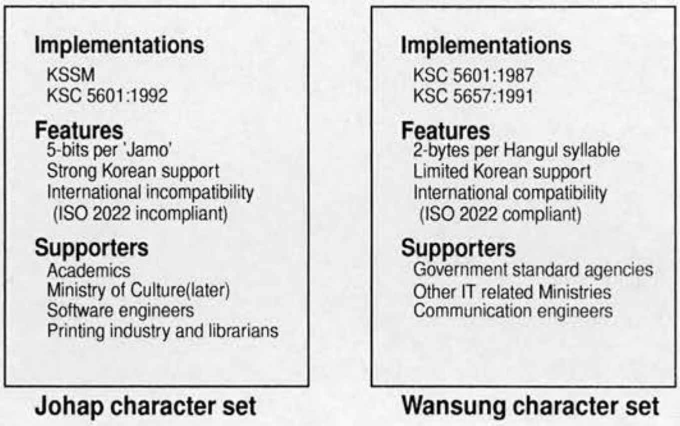


Figure 6.2: Comparison between major features of the two rival character sets

pressure of the public mobilisation. Section 6.1 describes the two failed government attempts to set up national standards. Section 6.2 then shows the emergence of the first successful national standard. Section 6.3 follows the growing voices of criticism against the new standard from a group of experts and the first amendment to the standard in 1991. Then section 6.4 describes the process by which the wider public became engaged in the standard setting and persuaded the government to accept a radical change in the national standard in 1992.

6.1 Industry without standard: before 1987

Writing in Korea consists mainly of indigenous script, 'Hangul,' Chinese characters, 'Hanja,' and Arabic numbers. Therefore, when mainframes and minicomputer were imported in the 1960s and the early 1970s, with their English input/output systems, it soon became clear that the Korean-enabled input/output system would be a key element for the successful exploitation and diffusion of computer technology in Korea. However, the early importers of the mainframes and minicomputers were the government, financial institutions, universities, and large corporations whose main concern was its centralised batch processing of large-scale numerical data. The development of Korean character set was left to the individual manufacturer, and specialised importers, and to user organisations for its own use. Up until the early 1970s, there was no concerted national level effort for establishing a standardised Korean character set.

However, as the demands of Korean data processing grew, and the volumes of processed data accumulated, the virtual incompatibility between computer systems began to alarm the government about the danger of creating isolated incompatible databases. As an industrial policy designer of highest order, the government was concerned with the fragmentation of databases and the computer industry. Recognised this trend as a potential threat to the nascent computer industry, the Ministry of Science and Technology (MST) commissioned the Korean Institute of Science and Technology (KIST)[1] to develop a national character set standard in 1974. The commission resulted in the first Korean national character set, KSC 5601:1974.[2] The standard was a variable length 7-bit N-byte code which allocates a 7-bit code point to 57 Jamo. In that standard, KIST actually adopted the structure of the most common type of Korean character set at the time, but the exact mapping between the 7-bit code and Jamo was not identical with other existing implementations. This meant costly change and potential disruption to existing data processing practices for organisations who had already purchased or developed various Korean input/output systems with proprietary Korean character sets. Apart from publishing the new standard, the government provided little incentives to persuade the industry to abandon their proprietary standards and to switch to the new national standard. The standard had virtually no effect on industry practices, and the first government attempt to set up a national Korean character set standard failed.

Close to the end of the 1970s, the computer industry had grown from almost non-existence to a small but rapidly growing sector in Korea. As the advent

[1] KIST, the most prestigious government funded R&D institute, was founded by the government in 1966 to perform scientific and technological research for the development of industrial technology.

[2] KSC 5601:1974 Korean Industrial Standard Code for Information Exchange (Hangul and Hanja). It was approved by the Industrial Advancement Administration in September, and published by the Korean Standards Association in November 1974.

of mini-computers lowered the costs and enhanced the reliability of computers, new specialist companies emerged in order to cater for growing demands for the mini-computers and related services.[3] From the mid-1970s, with the successes of those specialist companies, Korean conglomerates such as Samsung Electronics, Goldstar, Daewoo, Kumho, Sun-Kyung, Ssang-Yong, Doo-San, were convinced about the potential of the computer in the future and decided to enter the market. Without having necessary technologies, the first step was a search for possible source of technology transfer in the field, in particular, of minicomputers. They started joint ventures with or obtained franchises from U.S. and Japanese companies, such as Hewlett-Packard (HP), Wang Laboratories, Digital Equipment Corporation (DEC), Nippon Electric Corporation (NEC), and Fujitsu.

The core strategy of these Korean companies was to gain as high a market share as possible in the emerging Korean market. For example, Samsung Electronics participated in the public tender of nine minicomputers for nine universities by the Ministry of Education in 1977, and bid at half the international market price (Seo 1997, pp.129-130). In this vein, leading companies applied competitive rather than cooperative strategies to the Korean character set design, each developing its own proprietary Korean character set. This practice was believed to reinforce the market position of a provider by helping it to lock-in users who invested in the hardware and software of a specific company whose character set is different from other companies. Changing suppliers in this situation would mean the discontinuity of databases and compatibility problems with previous installations. The success of the domestic computing industry, therefore, also generated a serious problem of incompatibility of character sets. There were virtually the as many Korean character sets as the number of companies producing and marketing computers in Korea.

[3]International Data System Corporation (IDsC)(1974), Korea New Com (1973), Oriental Computer Engineering (OCE) (1975) ran successful business as agents for Data General (DG), Digital Equipment Corporation (DEC), and Wang Laboratories respectively.

Under these circumstances, the government made a second attempt to standardise the Korean character set in 1980. The Ministry of Science and Technology again took the initiative. After conducting a survey of standardisation among related government branches, industry, and academics in October, it called for a special conference in December 1980 in order to promote standardisation in the computer industry. This induced a broad participation including the representatives from six government branches,[4] industry, academy, research institutions and various levels of users. The conference succeeded in publicise and share the urgency of the issue and decided to set up a computer standardisation promotion committee and a taskforce which would survey the market and design a new standard draft with the assistance of an advisory committee. The taskforce worked on the standardisation project from May 1981 to January 1982, and produced a draft in January 1982 which was passed into a new Korean national character set standard, KS C 5601:1982 in May 1982.

The new standard had a basic character set and two additional supplementary sets. The basic set was the same as KS C 5601:1974 which was 7bit, N-byte code, and the supplementary sets were 2-byte Johap code and 8-bit N-byte code. Therefore, the purpose of the new standard was not to set up one definitive national standard but to guide the chaotic competition of two dozens proprietary character sets into the codification of three existing types of character sets. In a sense, this was an acknowledgment of the current corporate practices, for it incorporated the two most common character set designs into the national standard. The 2-byte Johap was based on the character sets used by IBM, Sambo computers, and Qnix. Also 8-bit N-byte was based on the popular characters set design used by the Control Data, Sperry and Apple. Therefore, the companies with those character set types could comply with the new standard with small modifications on their character set. However, it still requires changes of

[4] Ministry of Science and Technology, Ministry of Trade and Industry, Ministry of Post, Ministry of Education, Ministry of Home Affairs, Ministry of Government Administration.

mapping scheme within the given character set type, and this only meant additional cost and potential loss of locked-in users for many companies at the time. For those companies with non standard type character sets, such as, 7-bit 2-byte Wansung, or 3-byte, this would incur more radical and costly change. Without a compensating incentive in sight, the industry remained indifferent to the new national standard. The second standardisation attempt became another failure.

6.2 National standard KS C 5601-1987

Around the time when the KS C 5601:1982 was tested, a new trend was emerging in the computer industry: the introduction and rapid popularisation of personal computers. In 1975, one of the first microprocessor-based computers, Altair 8800, pioneered the personal computer market in U.S., using Intel's 8080 microprocessor. During 1975-1977, the success of Apple II, Commodore PET, and Tandy TRS-80 challenged the image of the personal computer as an exclusive hobbyist gadget and transformed it into a consumer product. Also system software and application software, such as spreadsheets, word-processors, and database programs became available in the market during the late 1970s and early 1980s, opening a new prospect for the personal computer as a business machine.[5] The trend culminated with the launch of the IBM Personal Computer in 1981, which quickly became the industry standard architecture for personal computer (Campbell-Kelly & Aspray 1996, Ceruzzi 1998).

The microcomputer boom was also reflected in the Korean market from the late 1970s. The Apple II and Tandy's TRS-80 were imported for the increasing number of hobbyists. Growing interest in the microcomputer can be witnessed in an early effort to build a Korean microcomputer, the GS COM80A, jointly built by the KIST and Goldstar Electronics in 1977 using Intel 8080A microprocessor.[6] In the early 1980s, Apple II, TRS 80, MSX series, Osborne were the typical imported

[5]Well known examples are CP/M (1976) and MS-DOS (1981) for operating system, WordStar (1979) and WordPerfect (1982) for word-processor, VisiCalc (1979) and Lotus 1-2-3 (1983) for spreadsheet, dBase II (1980) and PFS:File (1980) for database.

[6]GS COM80A used CP/M80 as system software and BASIC for application development.

microcomputers on sale, and the Sambo computer was the only Korean computer with SE 8001 on market. However, in general, personal computers were too expensive to reach the mass market in Korea at the time, and none of Korean conglomerates showed an interest in microcomputers. Apart from Sambo computers and Elex computers, small independent shops in the Chun-Gae-Chun electronics mall built and sold 8-bit microcomputer clones by imported parts. Most observers had strong doubt about the prospects of the personal computer industry in Korea in the early 1980s.

Then, two of the most important stimuli for embryonic Korean microcomputer industry came from the government. In February 1982, the Ministry of Science and Technology launched an ambitious 'Educational Computer Promotion Project,' which aimed to supply 5,000 personal computers to schools under the government budget. This was an unprecedented amount for a single order by the standards of the time. The Ministry of Trade and Industry also announced a 'Selection guide for Computer Industry Leaders,' implying that the government would select and promote a few competitive companies. Even though the implementation of both projects were delayed or scrapped later, the two projects successfully achieved the government objectives of boosting the domestic microcomputer industry and to enhance the awareness of the microcomputer among the public in general. Companies with experience in the minicomputers and mainframe industries such as Samsung Electronics, Daewoo Electronics, GoldStar, began to consider the microcomputer market through the educational computer promotion project, and many other companies in the electronics field hurried to invest in the production of computer parts for fear of being excluded from the government plan for 'selective support.' Towards the middle of 1980s, the microcomputers began to take an increasingly dominant place in the Korean computer market.

As the personal computer became more widespread among individual users and office workers in organisations, the success of the microcomputer industry in the domestic market became more and more dependent on the adequate Korean input/output system. Typical users of the mainframes and minicomputers were government bureaux, scientific institutions and business organisations concerned about the number crunching of formalised and large scale data. Also, most user organisations of this kind could afford the extra personnel needed for the translation or codification of Korean raw data into English. However, most personal computer users commonly dealt with less formalised data, and preferred the real-time interactions with their machine. For the Korean computer industry to capitalise on the personal computer boom, it needed to develop an adequate Korean support available for popular applications, such as, spreadsheets, word-processors, and databases.

Meanwhile, in the mid-1980s, when the 16-bit IBM PC architecture began to dominate the personal computer market, the trend of Korean character set design also changed. The second national standard, KSC 5601:1982 essentially inherited the byte-oriented structure of KSC 5601:1974, giving a new double-byte supplementary character set less than a minor role. However, the winners from the market competition in the mid-1980s were a group of fixed length double-byte character set exploiting the 16-bit architecture of the IBM PC. Scores of implementations of these double-byte character sets had existed, vying for the position of de factor standard for the growing personal computer market, and most of serious contenders could be categorised into two broad types, Johap and Wansung.

Wansung and Johap were names given to the two character set designs. As explained in section 5.3, the two designs are based on different approaches to Korean script encoding, resulting in contrasting advantages and shortcomings in terms of the two main criteria against which the Korean character set were often judged, that is, the level of Korean script support and international compatibility. First, Johap provided users with much more powerful support for

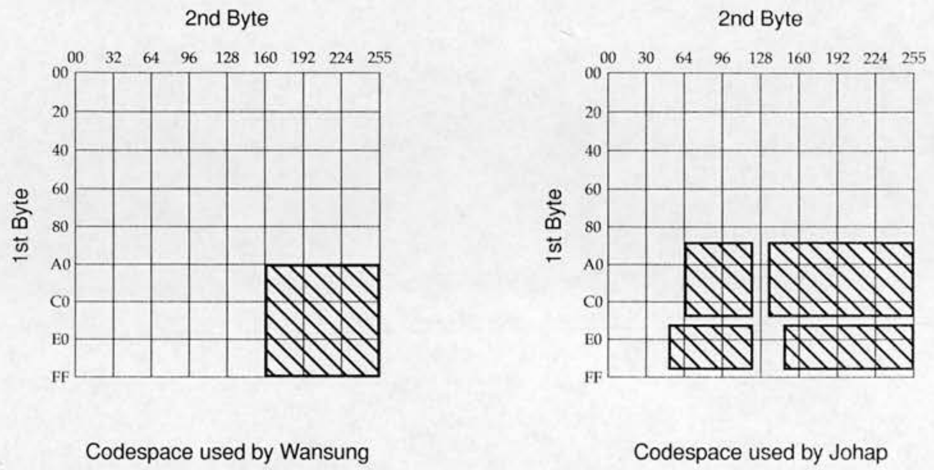


Figure 6.3: Code points used by two rival character set, Wansung and Johap.

Korean script. Implementation of Johap enables users to utilise all 11,172 modern Hangul syllables with thousands of Chinese characters.[7] However, Johap also had a comparable weakness in an equally important factor, that is, it was incompatible with the contemporary international standard regime, ISO 2022. As shown in Figure 6.3, Johap uses far more code space beyond the area permitted by ISO 2022 and this causes disruption in ISO 2022 compliant system.

On the other hand, Wansung has exactly opposite characters of Johap. The code space taken up by Wansung is within the area allowed by ISO 2022 rules. This means that the data encoded by Wansung could be used in or exchanged between systems compliant to the international standard regime. However, compliance with the ISO 2022 rules led to the substantial reduction of code space from 65,536 (256 by 256), the maximum space that could be made by two 8-bit byte stream to a mere 8,836 (94 by 94). Since the total code space is smaller than

[7] KSSM, one of the most popular implementation of Johap, for example, has all 11,172 modern Hangul syllables, 4,888 Chinese characters, and 960 symbols.

the repertoire of modern Hangul syllables (11,172), there should be some limitations in Korean script usage. Moreover, depending on the writing style and requirement of documents,[8] common Korean writing requires thousands of Chinese characters. This intensifies the problem of code space shortage. The KSC 5601:1987, for example, assigns 4,448 code space to Chinese characters, and allowed only 2,350 Hangul syllables, about one fifth of the total modern Hangul syllable. Figure 6.3 compares the code space taken up by Wansung and those utilised by Johap.

Meanwhile, the Korean government had been preparing for the National Backbone Computer Network Project from 1982. The project involved the networking of computerised administrative, financial, educational, defence and security systems. It aimed to boost demands for the computer industry, to encourage systematic informatisation policy, and to achieve an efficient government. After four years of inter-departmental struggle for leadership and the development of detailed implementation plan, the project committee recommendation was passed in parliament in 1985 to the effect that the first step of the project, the administrative network, would start in 1987. In terms of the overall implementation of the project required, the key issue was to secure the necessary budget for the equipment and expertise. From the technical point of view, however, one of the most urgent and intractable problems was the absence of a widely accepted national character set standard. Considering the nature of the project - networking wide-ranging computer systems for information exchange - it was clear that a standard Korean character set was an important precondition for the project.

The task of standardisation of the character set was assigned to the Ministry of Science and Technology, and it contracted out the standardisation project to the Korea Standards Research Institute (KSRI)[9] in 1985. Being aware of previous failures and difficulties involved, the KSRI proceeded carefully in order to create

[8]For example, compulsory national ID card has holder's name both in Hangul and Chinese character.

[9]The KSRI was established as a central authority of national standards system in December 1975, and renamed into Korea Research Institute of Standards and Science (KRISS) in October 1991.

a consensus about the new national standard. It reviewed relevant literatures and conducted a survey on the character set usages of 441 organisations from industry, academic and research institutions by interviews and questionnaire from September to October 1985.[10] Then, the KSRI elected twelve expert advisors from research institutes, university, and government, and hosted the first advisory committee meeting at the end of 1985 for consultation. The research and consultation produced basic guidelines for the prospective standard, three major points of which are the unification of existing character set standards, observance of international standards, and public consultation (Korean Standards Research Institute 1987, pp.39-44). After having a conference with industry leaders in February 1986, the second advisory committee meeting decided that the two most popular forms of character sets should form bases of the new standard. It recommended therefore, that the KSRI should make two alternative standards drafts based on Johap and Wansung, and then the next session of advisory committee would select between the two after public consultation and further discussion. Therefore, real candidates of the new standard were narrowed down to a competition between the two preliminary drafts based on Johap and Wansung.

Two preliminary drafts were soon produced. In March 1986, the both drafts were submitted to the discussion of the advisory committee, and also another industry survey was carried out among 29 industry leaders. According to the survey, the industry, as a whole, was in favour of Johap proposal, reflecting the popularity of various Johap implementations in the market. Among the 15 companies that responded, 7 voted for Johap and 4 for Wansung. However, the advisory committee was leaning towards Wansung draft. In the third advisory committee meeting on 26 March, participants agreed on the relative merits of Wansung over Johap proposal mostly for its compatibility with international standard ISO 2022 (Korean Standards Research Institute 1987).

[10]Showing the status of national standards in the field at the time, only 36 organisations responded to the questionnaire.

However, the KSRI was reluctant to proceed with the proposal, for there was substantial majority of industry who supported Johap proposal. In June 1986, a public hearing was organised to discuss the matter with the wider public. In the public hearing, neither of proposals could obtain majority support, for each proposal drew on strong support of equally influential participant groups. Rather than eliminating one proposal in favour of the other, the public hearing raised the possibility of a dual standard system which would acknowledge both Johap and Wansung proposals as national standard. The ensuing experts forum in September, however, insisted on the merit of single standard. When the fifth committee meeting was convened in December 1986, the pressure of the schedule from the computerisation project made the advisory committee decide the final recommendation on the basis of internal consensus rather than the broad consensus including industry. In March 1987, Wansung proposal was passed into the new Korean national character set standard, KS C 5601:1987.

The contrasting preference for the two proposals between industry and the advisory committee showed reflects the differences in their backgrounds and main priorities in relation to the character set standards. Personal computer industry representatives consulted in the surveys were the Korean manufacturers of computers and software developers. They varied in size and technological sophistication, but most of them were primarily based on the burgeoning personal computer market. A powerful Korean input/output system was one of the key marketing points for the personal computer, and Johap character set was the most popular character set in the mass market because it supported the complete Korean repertoire. On the other hand, most advisory committee members[11] had backgrounds in managing large scale systems based on mainframe computers or minicomputers. To them, the primary criterion for the character set was compliance with the international standard ISO 2022 on which most of imported hardware and software system was based.

[11] Four experts advisors were from government branches, four from government funded research institutes, one from university, two from data telephone companies, one from army intelligence.

Even though Wansung design was passed into a national standard, success in the market was another matter. Previous attempts at standardisation in 1974 and 1982 had had little impact on the actual practices of industry. The argument for the overall benefits for industry was too weak to reverse the competitive practices of which the proprietary character set was an essential part. Also, there was no legal privilege granted to the two former national standards. The KSC 5601:1987, however, was thought to fare better, for it was developed as a part of the national backbone computer network project. During the standardisation process for the character set, the first stage of the project - the Government Administrative Network - was already in preparation. Soon after the standard was passed, in 1988, the government included the new standard in the government procurement specifications for the computer network project.[12] One year later, it was followed by the decision of the educational computer project that the equipment for the project should be compatible with those of the administrative network.

As the first nation-wide computerised administrative network, it required the largest ever procurement of microcomputer hardware and software in Korea. It was not difficult to imagine that the standards and practices adopted in this first network project would be a model for further network projects. Moreover, the educational market had been one of major strategic targets of the computer industry for its influence on future demands. When these two projects opted for the new national character set standard, virtually all domestic manufacturers and software developers changed their basic character set according to the new national standard. When Microsoft Korea decided to abandon Johap character set and issued a new version of Korean MS-DOS 4.0 based on the new standard, and Unix followed suit, the trend seemed irreversible. More quickly than anyone

[12]Korean industrial standard, KSC 5842 Personal Computer (1), recognised the national standard KSC 5601:1987 as the only official character set used for government personal computer specifications.

expected, the new national standard KSC5601: 1987 became a 'de facto' Korean character set standard as well as 'de jure'.

6.3 Dispute among experts and the first amendment: KS C 5657:1991

Both the government computer network project and the standardisation of the Korean character set became major catalysts for the diffusion of personal computers in Korea. With increasing pace, manufacturers produced IBM PC clones equipped with various Korean input/output solutions based on the new national character set standard. At all levels of Korean encoding solutions described in section 5.2, the new Korean standard became a default character set or one of the primary options to be supported. With the growing popularity of the new national standard, there is growing possibility of information exchange across different brands of hardware and software. Independent software producers began to emerge to exploit this suddenly expanded common market. Also, on-line services[13] which had begun in 1986 could provide more reliable services to the public without the problem of data corruption. In the late 1980s and early 1990s, the personal computer industry was growing fast both in terms of production and sales volume and the penetration of computer into the daily lives of an increasing number of people. The computer industry as a whole achieved a total production value of 2.4 billion US dollars in 1988 and 2.9 billion US dollars in 1989 with a 30 per cent growth rate. The total number of personal computer circulation in 1988 reached 650,000 from less than 1,000 in 1983 (Science & Technology Policy Institute 1997, p.282).

Amid the boom of personal computer, however, voices of criticism against the new national standard began to be heard. The main cause of the criticism was the limited Korean character support by the national standard. This was a main weakness of Wansung proposal during the standard setting process but had been

[13]Early on-line service networks, such as Chollian, PC-VAN, KETEL adopted the new standard.

accepted by the advisory committee, on the basis of the studies suggesting that the 2,350 Hangul syllables could cover the absolute majority of Hangul syllables used in everyday life[14] and that the limitation would cause a few inconveniences rather than serious problems. However, there was a fundamental change in the way the issue was discussed. While the standardisation of the KSC 5601:1987 was dominated by the government taskforce and exclusive circles of advisory committee with the feedback from industry, the criticism made against the implementation of the standard and the subsequent discussions on the issue were brought into the public arena.

In 1989 and 1990, groups of software engineers and academics in the fields of language and computer science broached the subject through on-line discussion groups, newspapers, and special magazines articles, and engaged in a campaign of criticism against the KSC 5601:1987. The debate in the media involved specialists from government agencies, computer industry experts, and other experts in related fields. Also included here was a group of academics in the field of literature and language who raised the concern for the adverse influence of the new standard on education and the development of Korean language.[15] Through the debates, the critics publicly challenged the judgement of the advisory committee, arguing that the choice of Wansung would cause much greater long-term damage than trivial inconveniences. The main argument was three-fold. First, the shortage of Hangul syllables would obstruct a free expression of Korean language, the value of which could not be quantified as had been attempted by Wansung proponents in the form of frequency distribution of any given Hangul syllables. Second, the Johap character set is essential for more efficient Korean language processing, for each code point encoded in Johap has information about constituent elements of the Hangul syllable it represents (decomposition into Jamo). This was essential for more sophisticated language processing, such as

[14]Depending on the studies, the coverage of normal text by the 2,350 Hangul syllable were 97 per cent to 99.9999 per cent. See Lee (1990*b*) Saving Hangul and Park (1990) Expansion plan of Korean character set.

[15]Kim (1989) Problem and solution of education computer.

spelling check, automatic translation, grammatical analysis. Third, the committee had unduly emphasised the need for international compatibility, which had little relevance to most of personal computer users (Ahn 1989a;1989b, Kim 1989, Park 1989) . Defender of Wansung conversely argued the importance of internationally compatible Korean character set (Ryu 1989a;1989b;1990) . In terms of the range of participants directly involved in the debates on media, the dispute had not transformed into a full-scale public debate at this stage. However, for the first time, the issue of Korean character set was brought to the public domain beyond the closed government advisory committee.

By early 1990, the government was under domestic and international pressure. On the one hand, the domestic criticism had been increasing in intensity. At the same time, the ISO/IEC JTC1 SC2/WG2 requested a comprehensive list of characters in Korean standards in order to incorporate those in the repertoire of Universal Character Set (UCS), a future generation of international character set standard being developed by the formal standardisation organisation. Korean delegates were requested to submit an extended character set in the 18th meeting of ISO/IEC JTC1 SC2/WG2 in September 1990. In March 1990 the government decided to amend the KSC 5601:1987. The Ministry of Post and Telecommunications announced that the KSRI would design an amendment proposal through a ten-month research project and the resulting proposal would be approved through a series of public hearings.

The announcement of the amendment plan was welcomed by the critics of KSC 5601: 1987, for the government's rationale of the amendment plan was in line with one of their main arguments that the shortage of Hangul syllables in the current standard should be addressed. However, at the same time, the critics also had misgivings about the possibility that the amendment would not be a much-awaited overhaul of the standard but a mere cosmetic change leaving the current structure intact. Newspaper interview given by the research team leader of KSRI hinted that the basic idea of the team was to add one or two supplementary tables to the current standard for users with special needs (Park 1990). Through articles on newspapers and magazines, advocates of Johap soon began to voice their concerns about the KSRI plan, and demanded nothing less than a wholesale structural change from Wansung to Johap (Kang 1990a;1990b, Lee 1990b). On the other hand, the supporters of the Wansung standard defended the merits of the existing standard and the basic idea of the amendment plan (Cho 1990).

The polarization of opinions into two warring camps between Johap and Wansung supporters became clear in a conference held by the DACOM PC-SERVE[16] on-line community, '21st century village,' in April 1990, a month from the announcement. The conference organisers invited two prominent supporters from each camp as speakers. Dong-Soon Park and Chul-Hee Kang from KSRI and government funded research institutes and spoke for Wansung, and Choong-Hoe Kim and Tae-Jin Kang from academy and software industry argued for Johap. Each of these two groups of speakers formed a united front. Johap supporters insisted that the fundamental flaws in the KSC 5601:1987 could only be addressed by replacing Wansung standard with Johap, or at least, making Johap into another national standard of equal status. Defenders of Wansung standard were also adamant that the problems with the KSC 5601:1987 could and should be solved within the ISO-2022 rules. Heated discussion over the direction of the amendment ended in confirming the uncompromising stances of both camps.

In April 1991, the commissioned study finally produced a recommendation and the Ministry of Post and Telecommunication issued a report, 'A Study on the Expansion of Hangul/Hanja Code for Information Interchange and its implementation on PC.' As was shown in the name of the study, it was essentially an extension method on the existing standard. The amendment, it explains, would maintain the existing standard, the KSC 5601:1987, add two supplementary sets

[16]PC-SERVE is one of the earliest on-line services provided by DACOM. Founded in 1982, the DACOM pioneered on-line services with e-mail, BBS, file transfer services from the mid-1980s.

to be invoked when there is need for wider repertoires beyond the existing standard. Each supplementary set was designed to cater for different requirements. The first supplementary set had a mixture of an additional 1,930 Hangul syllables, 2,865 Chinese characters, 1,754 Old Korean Jamo and Hangul syllables, and 1,410 other symbols. This would be invoked for the users with character shortage in old or modern Korean, Chinese characters, or symbols. The second supplementary set included 6,892 Hangul syllables which were omitted by the KSC 5601: 1987 and supplementary set one. It was designed for the users who want to use all 11,172 modern Korean syllables (Korean Standards Research Institute, 1991).

The response from the critics was of disappointment and disbelief. For the critics, it seemed that the KSRI and Ministry of Post and Telecommunication had completely ignored all the criticisms raised against the KSC 5601:1987 and the initial amendment plan. The report distributed by the Ministry of Post and Telecommunications specifically mentioned two guidelines for the design of the amendment, first, the research should be based on the extension of ISO-2022 compatible current Wansung standard. Second, Johap code is beyond the remit of the study commissioned, and should be dealt with by a separate project (Korean Standards Research Institute 1991). Therefore, even though the government had engaged with critics in a conference and public hearings, the most important design decision was made by the government from the beginning of the project and was not changed in any significant way. A comment by one critic expressed the frustration of Johap supporters.

> The study produced a code so inconsistent and inadequate as a standard that anyone would suspect the purpose of the standard was only to appease and distract the discontent users. Considering the title of study, 'expansion... of code,' it appears rather natural that it was a repetition of existing problems (Ahn 1991, p.170).

From Johap supporters' viewpoint, the recommendation did not address the fundamental problem but tried to alleviate one of many symptoms of the fundamental flaw of the existing standard. The critics argued that the recommendation would damage further Korean information processing, for the Hangul syllables were scattered along three different tables (Kang 1991). The only consolation for those critics could have been the fact that, in theory, it would be possible to utilise all 11,172 modern Hangul syllables, if the developers could find practical ways to deal with the complexity of multiple sets. However, the Standards Bureau decided to drop the second supplementary set due to its technical difficulties and objections at the 20th meeting of JTC1 SC2/WG2.

A public hearing was hosted in September in tense atmosphere. However, it failed to narrow the differences of both sides, but only exacerbate the relations between the two groups. While Johap supporters wanted to discuss the design of amendment plan more thoroughly, the government assumed the issue to have been settled by the KSRI proposal and wanted to focus on the issue of emerging new international standard project, UCS. For example, the KSRI project leader, Park Dong Soon, who were supposed to explain the update of the project to audience was absent, and the other experts from KSRI made clear that the government standards team was closely following the development of UCS and even having a plan to accept it as national standard in the future (Shim 1991). Despite the failure of public hearing, the government pushed on for the standardisation of the draft. In October 1991, the first amendment of KS C 5601:1987 was passed through parliament only with the first supplementary set and announced as the national standard KSC 5657:1991 in December 1991 (Industrial Advancement Administration 1991*b*). The original plan was to test the supplementary set in the market for one year before conferring standard status, but the testing period was cancelled out in order to submit the list of Korean character set to the 21st meeting of ISO/IEC JTC1 SC2/WG2 on the same month.

6.4 Public Controversy and second amendment : KS C 5601: 1992

In general, the standard setting process for KSC 5657 was an essentially government-centred and unilateral one. Even though the outside critics played an important part in initiating the whole process, their influence was minimal in selecting the guidelines and in designing the draft. The behaviour of government during the amendment process seems to show that the pressure from the ISO's request had more influence than the vocal domestic critics both on the initial decision for the amendment and the directions taken in the technical design of the KSC 5657. However, frustrated with the one-sided process, some of proponents of Johap began to consolidate their informal networks and set up organisation to mobilise the experts and public more efficiently. Though it was too late to have any meaningful impact on the KSC 5657 setting process, it would radically transform the standardisation process for the second amendment of KSC 5601:1987 later in 1992. The two most active organisations were the Alliance for Promoting Johap Standard and the Association for Korean Character Set Standardisation.

From April 1991, a group of young scientists and engineers who shared a concern for the character set standardisation agreed to form an NGO in order to become a more effective pressure group on the character set standardisation issue. In June 1991, core members of the group set up a taskforce to prepare the formation of an NGO dedicated to the character set standardisation issue, and provisionally named it, 'Alliance for Promoting Johap Standard.' According to the announcement of the taskforce in mass media, the organisation argued that the main reason of the current stalemate was the government's inadequate understanding of the Korean script and the lack of will to solve the problem. Therefore, users had to organise themselves and try actively to solve the problem rather than to wait passively the actions of government agencies. It set up two main targets. First, it would work as a pressure group for The Johap character set. This would involve the further alliances with other experts and organisation and the mobilisation of the public for the cause. Even though the character set standardisation had began to be discussed outside the realm of the government project since 1989, the range of the discussants had been limited to a few engineers from industry and government research institutes and experts users, due to the low publicity and technical nature of the issue. In order to remedy this situation, it should prepare and circulate a compact and persuasive technical argument for Johap standard through the mass media, such as major newspapers, magazines, and broadcasters. Public hearings and conferences were organised to maximise the publicity. Members with expertise actively took part in relevant meetings and gatherings in industry, academic, and political circles. A growing on-line community was also targeted for the campaign. Also, the task force started collecting signatures for a petition to the government to the effect that the public wanted more transparency and accountability from the Standards Bureau and changes in the national standard. Second, it would conduct a research on the character set in order to prepare a viable substitute based on Johap (Alliance for Promoting Johap Standard 1991a; 1991b).

Another civic organisation was founded in September the same year. The initiative came from the 'Computer Aided Publishing Society (CAPSO).' At the end of August 1991, immediately before the public hearing in September, the president of the CAPSO called for a concerted action among interested parties against the government plan to pass what they saw as an inadequate amendment without a public consensus. As was mentioned earlier, however, the perspectives of government standard agency and Johap supporters were very different over the role of the public hearing. Only interested in the application of Korean repertoire to the UCS project, the government not only failed to persuade the critics of the KSRI amendment (Johap supporters) and form a wider consensus on the KSC 5657, but also reinforced the widespread mistrust towards the government on the national character set standardisation. Just a week after the public hearing, the 'Association for Korean Character Set Standardisation' was formally inaugurated on the ninth of September, arguing that the inferior design of KSC 5657 and government's disrespect for public opinion left no option but to organised themselves to produce a legitimate national standard.[17] Initial membership of the association included 13 organisations and 10 individuals, ranged from industry experts, researchers, scholars on computer science, publishers, librarians, and academics in linguistics, some of whom had become renowned figures through the on-line and media discussion of the issue. The position of the association on the character set standards issue was that the Johap character set should either replace the existing Wansung standard or become a national standard at least for the personal computer. The association immediately raised funds and set up research teams to design a version of Johap character set for a viable alternative.

The backgrounds of both NGOs was the government dealings with the KSC 5657:1991, the first amendment of KSC 5601:1987. The Alliance for Promoting Johap Standard set up its taskforce at the same month as the government announced its draft and its guidelines, and 'The Association for Korean Character Set standardisation' was born amid the public hearings for the KSC 5657. However, the activities of both NGOs could not influence the KSC 5657 setting process. Even though the taskforce had actively pursued its course of action, the setting up of the Alliance for Promoting Johap Standard took more than one year, and it could not operate as a formal channel for the critics in time for the KSC 5657. Also, the public hearing in September 1991 which helped 'the Association for Korean character set standardisation' to form was hosted in the final stage of the KSC 5657 setting process, leaving not enough time for the NGO to consolidate its position in the debate. Ironically, though, after the KSC 5657:1991 was passed into the national standard in December1991, both NGOs continued their activities in designing a viable Johap character set draft for the future standardisation, publicising the issue, and mobilising the public. Gradually, the issue of Korean character set standards was transforming from an arcane technical

[17] Association for Korean Character Set Standardisation (1991) Association Newsletter No. 1.

matter, with minimum interference from the public, into a highly sensitive and public issue, preparing for the dramatic victory in 1992 for the Johap supporters.

So far, all government branches had been holding a united front on the character set standard issue. Government branches, such as Ministry of Industry and Commerce, Ministry of Science and Technology, Ministry of Information and Communication and Ministry of Post and Telecommunication were all behind the position of the Standards Bureau, backing up Wansung type national standards. The newly established Ministry of Culture, however, found its own interests undermined by the government policy. The Ministry of culture had been inaugurated in 1990[18] and took over Korean language policy from Ministry of Education. From its inception, the Ministry of Culture pursued its own agenda, a computerisation and systematisation of Korean language research. Korean language policy division within the Ministry and the newly promoted National Academy of Korean Language were two main instruments. The Ministry was behind a series of projects, such as, the construction of Korean national corpus, electronic Korean dictionary, and dictionary of places names. The existing national standard KSC 5601:1987 and the proposed KSC 5657:1991 could not provide an adequate repertoire for those project requiring extremely large vocabulary. As a high ranking official from the Ministry of Culture said, it was a disturbing prospect to the Ministry who was enthusiastically embarking on a whole new sets of projects:

> One such occasion (problems with national standard) happened when we were assisting Korean Language Society's project of Korean dictionary for place name. We had come across with many words which was beyond the range of KSC 5601:1987, which was argued extremely unlikely to happen. Some of these words could not be found even in the KSC 5657:1991 which was devised to cover the words beyond the remit of 5601:1987. It was very disturbing because that's about the time when

[18]Jurisdiction of the new Ministry of Culture had formerly been exercised by Ministry of Information and Ministry of Education.

> Korean language society published its Korean dictionary, and we started our own project of Korean dictionary.[19]

In order to pursue its ambitious plan of computerisation of the Korean language data, the Ministry had to use a Korean character set powerful enough to encode all modern or preferably old Hangul syllable. Either the Ministry should develop its own proprietary character set or a special application for the computerisation project, or it should choose a Johap character set. For the former, there was a danger of creating powerful but incompatible database system. For the latter option, it still could choose to use a Johap character set regardless of the position of the government in general, or it could help the Johap campaign to make Johap a new national standard. The Ministry decided on the national standardisation of Johap, outsourcing a research on Korean character set standard and keyboard layout to a private software company, Haansoft, Inc. On 30 January 1992, the Ministry of Culture published a report, 'Basic research on Korean character set and keyboard (Ministry of Culture 1992)', which argued for the standardisation of Johap character set, creating, for the first time, a potential crack in the government position on the national character set issue. Later, the Ministry of Culture announced its position on the character set standard as pro-Johap in March, and furthermore, it officially requested the Standards Bureau to reconsider the status of Johap character set in May.

Encouraged by the support of the Ministry of Culture, the activities of the two NGOs also gathered pace, building broader alliances in the first half of 1992. Street campaigns were organised, signatures were collected, special conferences were held to exert more pressure on the Standards Bureau. Due to the much publicised campaign and media coverage, the public in general was better informed of the issue with detailed technical information as well as passionate cultural arguments for change. The public hearing in June 1992 marked a turning point of the controversy. Hosted by a group of media companies, it was also

[19] Interview with Won-Sun Lim, 22 July 2000

cosponsored by several related government branches, such as, Industrial Advancement Administration, Ministry of Education, Ministry of Commerce and Industry, Ministry of Science and Technology, Ministry of Culture, and Ministry of Post and Telecommunication.[20] Speakers from these government departments either supported Johap standard, or raised minor concerns for potential technical problems for implementation rather than objection in principle. For the first time, the overall government position was swayed towards Johap in the public hearing. Final confirmation came from the government sponsored public hearing in October 1992. This was an occasion for the Standards Bureau to unveil Johap draft it designed to interested parties and gather opinions on the design feature. In December1992, the Standards Bureau decided to accept a proposed version of Johap character set as a dual national standard in KS C 5601:1992.

6.5 Conclusion

The first phase of the Korean character set controversy during 1985-1992 was, in general, marked by competition between two distinctive character sets. The initial popularity of Johap character set had waned with the ascendancy of Wansung character set, as the latter obtained national standard status in 1987. Then, the support for Johap gradually regained force with increasing publicity as its supporters became organised during 1991-1992. The trend finally concluded with the inclusion of Johap character set in the second amendment of the KSC 5601 in 1992. From a relatively early stage, actors involved in the controversy identified the contrasting properties of each character set with straightforward implications for performance differentially affecting different user groups. This lead to the formation of two supporter groups behind each character set. In this regard, the ISO 2022 extension rules set the most important backdrop. Even

[20] In terms of number of hosts, sponsors, cosponsors, and discussants, this public hearing was the largest so far. Also, for the first time, the opinions of most of relevant government branches were represented here as well as other usual activists.

though the fundamental difference between the two approaches was the different unit of coding for Korean script, whether a syllable block or Jamo should be treated as a basic unit, but it was the ISO 2022 rules that made this design decision the single most important factor determining the basic feature of each character set and the performance of the application or system software utilising different character set types. Through the first phase of controversy, this remained stable. It was set prior to the controversy and had not changed in any significant way. What had been changing during the period were the effectiveness of persuasion of each supporter groups and the power relations between them as the competing campaigners drew support from experts and public in different degree of success.

CHAPTER 7

Transformation of international standards :

1990-1995

Straddling on both the first and second phases of the Korean controversy was a period of transformation of international standard regime between around 1990-1995. The initiatives for a more powerful multi-lingual international character set standard already appeared in the mid-1980s, but it was not until 1989 it began to improve its prospect as a future standard. Therefore, the movement towards the new international standards did not affect much of the first phase of Korean controversy. However, the momentum gathered in the late 1980s soon produced concrete results in the form of DIS 10646 in 1990 by ISO, the formal standardisation organisation, and Unicode 1.0 in 1991 by the Unicode consortium, a consortium of industry leader. The two standards were based on different structure initially, but later, the initial disagreement between the ISO and Unicode consortium over the shape of future multi-lingual character set was resolved in mid-1992, producing more harmonised ISO/IEC 10646-1:1993 and Unicode 2.0 in 1993. In terms of the Korean repertoire, however, the issue remained until the complete repertoire of modern Hangul syllables was included in 1995. For the Korean standards controversy, the two new standards had fundamental impacts on the positions and strategies of the actors in the related fields, shaping the directions of the Korean national standard setting at three important junctures of the second phase of local controversy in 1995, 1998, and 2000.

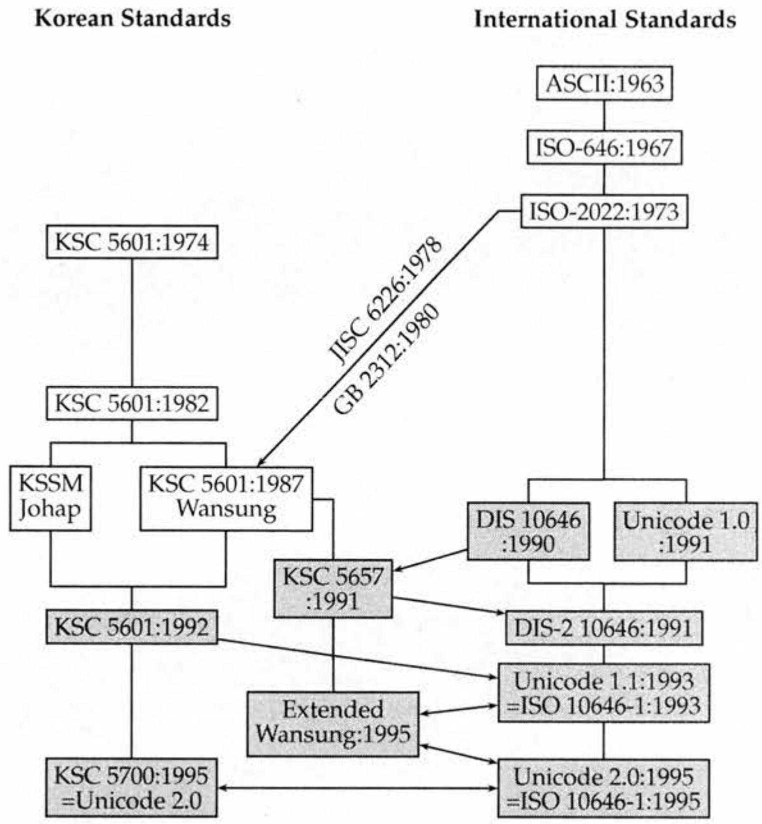


Figure 7.1: Korean and International Standards

Figure 7.1 shows the most relevant standards in both Korean and international standard regimes. DIS 10646 and Unicode 1.0 formed the first significant moves in the development of the new standard regime. Radical changes in the design of DIS-2 10646 was instrumental in the convergence of the efforts of ISO and Unicode consortium into the ISO 10646: 1993 and the Unicode 1.1: 1993. From the view point of Korean standards controversy, the most urgent and intractable problem of incomplete Korean repertoire was resolved finally in the ISO 10646:1996 and Unicode 2.0:1995.

Chapter 7 consists of four sections. Section 7.1 summarised the short history of the UCS and Unicode, the separate efforts to build a more powerful and stable multilingual character set standard by the ISO and Unicode consortium, and the later merger of the two. Three following sections describe the changes of Korean repertoire in the new standard. Section 7.2 shows the early involvement of Korean government in the formation of Korean repertoire and Chinese ideography in DIS 10646, and its influence on the design and controversy around the KSC 5657:1991. Section 7.3 describes a significant change made in the Korean government's standard policy towards a broad based public participation on the national and international standards setting process. The newly established expert committee assumed a crucial role to shape the new Korean repertoire during the structural changes in the DIS-2 10646. Section 7.4 follows the process in which further repertoire changes were made in UCS and Unicode in 1995 through the co-operation and alliances among former adversaries in Korean market: a full inclusion of 11,172, in the ISO 10646:1995 and Unicode 2.0: 1995.

7.1 Development of New International Standards: UCS and Unicode

Through the 1980s, it became clear that the problem with the ISO 2022 regime was not confined to a few countries with large character repertoire. For the ISO-2022 solution relied on the utilisation of same code points for different national character sets, there has always been a danger of data corruption. It adversely affected the prospect of multilingual environment of information technology as a whole. Increasing demands for international data traffic and multilingual data processing would require a more efficient and stable international character set than the outdated ISO 2022. Moreover, as a small number of software companies dominated a global software market based on standardised system software and common architecture, the new competition required developers to launch localised versions in different locales cheaply and quickly. Under the ISO 2022 environment, this was a costly and time-consuming process. The Unicode consortium explains the difficulties faced by the industry:

> When the Unicode project began in 1988, the groups most affected by the lack of a consistent international character standard included publishers of scientific and

> mathematical software, newspaper and book publishers, bibliographic information serviced, and academic researchers. More recently, the computer industry has adopted an increasingly global outlook, building international software that can be easily adapted to meet the needs of particular locations and cultures. The explosive growth of the Internet has merely added to the demand for a character set standard that can be used all over the world (Unicode Consortium 2000, p.3).

The search for a more stable and efficient international character set standard started in the mid-1980s and began to bear fruits in the form of UCS (Universal character set) and Unicode in the early 1990s, and this opened up new possibilities for the local controversy on character set in Korea.

The ISO began research on Universal Multiple-Octet Coded Character Set (UCS). A new working group, WG2, was established in 1984 under the Technical Committee 97, but its activities produced little result for years. When the JTC1 (Joint Technical Committee 1) was formed in 1987 by ISO and IEC for collaborated standardisation efforts in the field of information technology, the UCS project was revived again, producing a Draft International Standard, DIS 10646 in 1990. The structure of the DIS was called a canonical form of four-octet (32-bit), the representation of one character by four 8-bit bytes, also called UCS-4. This consists of 256 groups of 256 planes each of which has 256 rows with 256 cells within. Each plane, that is, 256 by 256 table, consists of 4 quadrants with CO, C1 control functions area reserved as under ISO 2022. Among 256 planes, the plane 32 of group 32 constitutes two-octet (16-bit) Basic Multilingual Plane (BMP) which includes most commonly used characters. Repertoire of national characters excluded from the BMP would be allocated a Supplementary Plane.[1]

Simultaneously, there have been efforts to overcome the limitation of ISO-2022 outside the formal standardisation organisation. In 1986, Xerox Corporation was the first company to explore the ways in which the existing national

[1] A plan for supplementary planes at the time was Plane 48 for Basic Chinese, plane 64 for Japanese, and plane 80 for Korean JTC1/SC2/WG2 (1991) Minutes of WG2 Meeting 20 - Geneva, Switzerland.

Year	UCS/Unicode	Summary
1989	DP 10646	Draft proposal, independent of Unicode
1990	DIS-1 10646	First draft, independent of Unicode
1991	Unicode 1.0	First version, independent of DIS
1991	DIS-2 10646	Second draft, merged with Unicode
1992	Unicode 1.0.1	First update, merged with DIS-2 10646
1993	IS 10646-1:1993	Merged standard, same codepoint with Unicode 1.1
1993	Unicode 1.1	Second update, same codepoint with IS 10646
1995	IS 10646-1:1995	Amendments, Korean realigned
1995	Unicode 2.0	Synchronised with IS amendments

Table 7.1: Timeline of UCS and Unicode

versions of Chinese character sets could be unified. Apple Computer, Inc. was also concerned with the unification of character set for a file exchange system. Soon both companies found common interest for the project and began cooperation for a new character set with multilingual capacity from 1987 with the term 'Unicode' used, implying a unique, universal and uniform solution for future character encoding. Through active researches in 1988, the Unicode working group was formed in 1989 with the growing participation of industry leaders including Metaphor, The Research Library Group, Sun Microsystems, Inc., Adobe Systems, Inc., Claris, Hewlett-Packard Company, NeXT Software, Inc., Pacific Rim Connections. In 1991, the working group transformed into Unicode Technical Committee, and the Unicode Consortium was formally founded by the incorporation into Unicode Inc. The same year, it produced the first Unicode standard, Unicode 1.0.

While both the Unicode consortium and ISO shared the vision of a single international multilingual character set, each had different approach to the project. Main concern of the Unicode consortium about the UCS project was the complexity and the size of the UCS-4. In order to make a powerful but compact character set, the Unicode decided on two main design features differently from the UCS project. First, it opted for sixteen-bit character set without the restriction of control functions area, opening up all 16-bit code points, 65,535 for printable characters. Second, it chose a principle of 'unification,' by which the Unicode allocates a code points to character equivalent in form across languages. The unification principle would save code points which had formerly used to encode the duplication of phonetic character, punctuation marks, symbols, and diacritics across different languages, and more importantly it could avoid the repeated allocation of code points to tens of thousands of common Chinese/Japanese/Korean ideographs[2] (Unicode Consortium 2000, pp.12-18).

Both projects searching for a universal international character set standard for all national characters, it seemed that the parallel existence of the UCS and Unicode would damage the rationale and prospect of both projects. In the former half of 1991, the DIS 10646 was being circulated for balloting of member countries, and Unicode 1.0 was in advanced stage for publication. As the possibility of fragmentation increased, the JTC1 and Unicode consortium intensified the efforts to merge the two standardisation projects. In July 1991, the DIS 10646 was disapproved by the ballot, 8 participating members voted in approval and 11 in disapproval, 2 observing members agreed and 3 objected.[3] Then, the JTC1 and Unicode consortium negotiated the merger between the DIS 10646 and Unicode 1.0. during the Summer and Autumn of 1992. Several changes were made in both DIS 10646 and Unicode 1.0., leading to the introduction of DIS-2 10646 and Unicode 1.0.1. The synchronised version of DIS-2 10646 opened the control function areas, C0, and C1 for coding of graphic characters. Also, the both groups agreed to use the Unified East Asian ideographs when it was made available by CJK-JRG, Chinese/Japanese/Korean Joint Research Group. The Unicode 1.0.1 were drafted with repertoire changes to accommodate DIS-2 10646. Further changes and harmonisation ensued in both standards during 1992, and the result were the publication of ISO/IEC 10646-1:1993 and Unicode 1.1 respectively in May and June 1992 with exactly the same code points for same characters. The vision

[2]This is called, CJK Unified ideographs, or Unified Han. See for more, Unicode Consortium (2000) Unicode 3.0. CJK Unified ideographs. pp.258-272

[3]Ballot of Draft International Standard requires approval from not less than 2/3 of participating members, (P-member) and disapproval from not more than 1/4 of total vote including observer members (O-member).

of new international character set standard finally became a viable alternative to ISO 2022 regime in 1992, now both officially recognised by the formal international standard organisation and supported by a consortium of most power software houses in the world.

7.2 Korean repertoire in DIS 10646

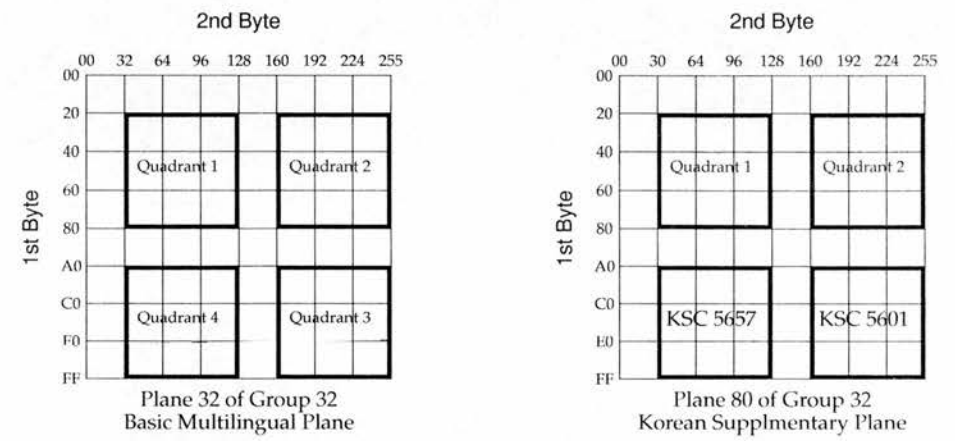
The first phase of Korean controversy over the character set standard had evolved around the clashes between different directions taken by government standard agencies on the one hand and by leading experts in industry, academics, and personal computer users on the other. However, a significant change for the future controversy was being made from late 1991, when the government constructed an official channel of consultancy with outside experts for more effective participation in the international standard setting process. The framework of cooperation was created first between the leading experts within and without the government standard agencies, and the positive experience of the cooperation even led to the strategic alliances between rival companies in the domestic market later. This section describes the process in which the actors in Korean character set standardisation sought and achieved strategic alliances in order to obtain favourable condition for Korean encoding in the new international character set standards.

Korean delegation began to participate in the ISO TC97/SC2/WG2 since 1987, from an early stage of UCS project. However, the activities of ISO TC97/SC2 did not attract much attention from domestic industry or government standard agency at the time. The prospect of UCS project was at best uncertain in that early stage, and the existence of UCS project itself was not known to most of actors involved in the Korean character set controversy. The UCS project did not appear in the public discussion either prior to and after the setting of KSC 5601:1987. However, the momentum gathered around the UCS project in the late 1980s rapidly improved its feasibility as a future international character set standard, and changed the position of government standard agency towards the project. Korean government began to actively involve in the unification of Chinese character sets of East Asian countries in 1989, and contributed to the establishment of CJK-JRG in February 1990.[4] As mentioned in section 6.3, the government began to show its interest on the new standards project during the KSC 5657:1991 setting process. When the government commissioned the KSRI to design a Korean character set extension set in March 1990, it was not only for answering domestic criticism against the national standard KSC 5601:1987, but also for preparing a new expanded Korean repertoire for the DIS 10646. In the 18th meeting of JTC1 SC2/WG2 in Munich in September 1990, Korean delegation applied for additional code space for Korean repertoire according to the result of the pending KSRI research. It was advised to submit the new repertoire until the end of year, but the actual supplementary set of KSC 5657:1991 were submitted to the 21st meeting of JTC1 SC2/WG2 meeting in Paris, October 1991, much later than planned.

Up to this stage, therefore, the structure of DIS 10646 was significantly different from the current one which was adopted since the ISO/IEC 10646-1:1993. They are similar in that both had the distinctive two tier structure; two-octet (16-bit) Basic Multilingual Plane (BMP) being couched in the four-octet (32-bit) canonical form, however, the planes of DIS 10646 including the BMP still observed the reservation of control functions area, C0, and C1 as proscribed in the ISO 2022 extension rules. This meant a substantial reduction in the code space of BMP from 65,536 to 36,864. More importantly for Korean controversy, this also meant Johap would be incompatible with the new international standard as it had been with the current standard ISO 2022. The restriction on C0 and C1 was

[4] A second ad hoc meeting on Han Unification was held in Seoul in February 1990. At this meeting, the Korean delegation proposed the establishment of a group composed of the East Asian countries and other interested organizations to study a unified Han encoding. From this informal meeting emerged the Chinese/Japanese/Korean Joint Research Group (Unicode Consortium 2000, p.961).

the main reason preventing Johap from being accepted as national standard and this remained unchanged in the new standard.



Codespace of BMP in DIS 10646 Korean Repertoire application

Figure 7.2: Code Space of DIS 10646 and KSC 5657:1991

The decision of ISO to maintain the control functions area C0 and C1 had important implications for the Korean controversy during 1990-1991. When the first amendment was discussed in 1990, the Standards Bureau did not mention the DIS 10646 at the time. The guidelines it presented to the project development team, however, stated that it should observe rules of the ISO 2022 (Korea Standards Research Institute 1991). Later, its intention was made clear during the public hearing (3 September 1991) where the Standards Bureau defended the design of KSRI proposal on the basis of an impending application to the UCS project.[5] The figure 7.2 shows the code space of DIS 10646 and the area claimed by the new Korean repertoire application to JTC1/SC2/WG2 with the KSC 5657:1991. Therefore, in that sense, the legacy of the ISO 2022 in the new

[5]For most of audience and participating members from outside of government, this was a news and seen as a proof that the government standard policy was not transparent (Association for Korean Character Set Standardisation 1991)

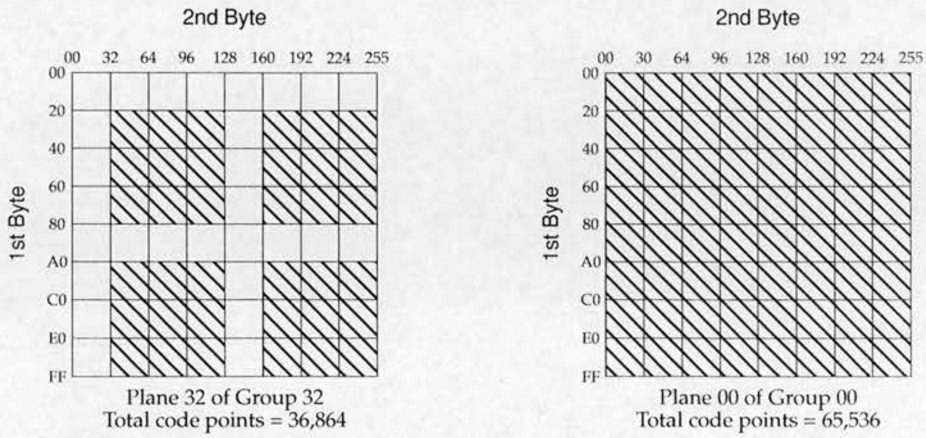
emerging international standard set determined the destiny of the local controversy, setting the Standard Bureau on collision course with the Johap supporters.

7.3 Korean Repertoire in DIS-2 10646

However, the structure of UCS underwent a radical change in 1991 amid the harmonisation efforts between the JTC1 and Unicode consortium. As was described in the section 7.1, JTC1 SC2/WG2 voted down the DIS 10646 in July 1991 and designed a new version, DIS-2 10646, accommodating the two major features of Unicode into the BMP: first, unrestricted use of BMP and the use of unified set of Chinese characters, which opened up the total codespace of 65536 as shown in Figure 7.3. The modification of the UCS design was of great significance to the Korean controversy as well as the long term prospect of the project itself. First, the removal of C0 and C1 area meant that Johap, in principle, had no fundamental conflict with the international standard regime. Second, the Han unification reduced the demands of code space from China, Japan, and Korean collectively, therefore, could open up large enough codespace for all Hangul syllables modern and old within the BMP. The relation between the international standard and Korean controversy was radically changed. This presented the first chance to work on Korean repertoire without as fundamental limitations as in ISO 2022.

Recognising the potential and risk involved in the new standard, the Korean government chose to strengthen the collaboration with experts outside of government. In July 1991, the government passed an ordinance,[6] stipulating the rules to set up and run experts technical committees that should undertake core tasks of Korean national member bodies of ISO and IEC, Industrial Advancement Administration. In relation to the character set issue, the legislation formed the basis of Korean experts technical committees in correspondence with JTC1 SC2 and SC2/WG2, the Korean JTC1/SC2 and Korean JTC1/SC2/WG2 respectively. The Korean JTC1/SC2 and JTC1/SC2/WG2 consist of experienced

[6]Industrial Advancement Administration (1991*a*) Guideline for Korean experts technical committee.



Code space of BMP in DIS 10646 Code space of BMP in DIS-2 10646

Figure 7.3: Structure of BMP : DIS 10646 and DIS-2 10646

experts from government, industry, academic and research institutes in the relevant fields. This was a novel approach from government in standardisation. While experts in industry or academic institutions had been consulted in most of previous government-led standardisation processes through advisory committee, survey and public hearing, the consultations were usually ad-hoc basis and limited to supportive role in both the KSC 5601:1987 and KSC 5657:1991. In the former case, the most important decision concerning structural design was made against the preference of industry leaders and the consultation of linguists were sought in last stage of the standardisation. In case of KSC 5657:1991, even though the Standard Bureau suffered intense criticism from outside experts in the field, the initial blueprint maintained unaffected by critics. The setting up of the Korean JTC1/SC2(WG2) would institutionalise the participation of the experts outside of government organisations for the first time for the government character set standardisation policy making process both for national and international standards.

The first meaningful contribution of the Experts Technical Committee came during the process in which the DIS-2 10646 was consolidated into the ISO 10646 : 1993 and the new Korean repertoire was realised in it. When the JTC1/SC2 (WG2) was set up, the KSC 5657:1991 was in the final phase of establishment, so it was too late for the new committee to intervene. However, when the DIS-2 10646 was drafted in the JTC1/SC2 and circulated among national members for ballot in June 1992, this was seen as a legitimate task for the new committee. The Expert Technical Committee was given the task of assessing the details of the DIS-2 10646 and preparing the Korean position for the DIS-2 ballot and for the 22nd meeting of JTC1 SC2/WG2 which was scheduled in July 1992 in Seoul, the capital of South Korea, in order to discuss the result of the ballot. From October 1991 to March 1992, the Korean SC2 and SC2/WG2 convened six times to determine the position of Korea on the DIS.[7] The main issue arisen from the discussions was that if the DIS-2 10646 had distinct possibility of becoming an international standard and being supported by major companies in near future, the lack of Korean repertoire in the BMP should be addressed sooner rather than later. All agreed that there was need for a change, but as diverse backgrounds of experts in the committee hinted, different approaches to the problem were proposed within in the Korean JTC1/SC2/WG2.

Five month deliberation finally produced a list of four proposals in order of preference within the committee (Korean JTC1/SC2, 1992). First, the BMP should include all 11,172 modern Hangul syllable in BMP and additional 240 Jamo for the Old Korean. This was the most favoured proposal among the committee members, due to its powerful Korean support and simple implementation. However, the prospect of this proposal being accepted by the JTC1/SC2/WG2 seemed

[7]Even though the legal framework was set up in the mid 1991, the JTC1/SC2(/WG2) became active from its first meeting held on 31 October 1991. The date of rest five meetings were: 2nd 21 November 1991, 3rd 12 December 1991, 4th 23rd January 1992, 5th 20 February 1992, 6th 13 March 1992.

low. The new design of the DIS-2 10646 created a SWAP area in order to encode additional future entry outside of BMP,[8] and this made the inclusion of further Korean repertoire in BMP unlikely during the ballot process of DIS-2 10646. While all of the members of Korean JTC/SC2/WG2 agreed that this should be primary Korean position on DIS2 10646, they also needed alternative proposals in order to enlarge the Korean repertoire when the first one were rejected. Three such proposals were drafted (Korean JTC1/SC2/WG2 1992*a*).

Second proposal (the first of three alternative) was that Korean encoding should use only 240 Jamo and use conjoining method to encode both modern and old Hangul syllables and Jamo. Therefore, Hangul syllable currently included in BMP, 2,350 Hangul syllables from KSC 5601:1987 and 1,930 Hangul syllables from KSC 5657:1991, should be removed and replaced with 240 new Jamo.[9] This is one of three alternatives if the meeting of JTC1/SC2/WG2 reject the first Korean proposal, the inclusion of all 11,172 modern Hangul syllable in BMP. In contrast to the proposal three and four, which mixes the new 240 Jamo and existing Hangul syllables, the proponents of the proposal two argued that the mixture of the limited number of Hangul syllables and the use of combining of 240 Jamo would produce a very complicated encoding environment. The second proposal with 240 Jamo drew many supporters from the pro-Johap camps. Usually academics or engineers in computer industry, many of them were either members of 'The Association for Korean Character Set Standardisation,' or 'Alliance for Promoting Johap Standard,' the two NGOs working for the inclusion of Johap in the national standard. The three prominent Johap supporters from the first round of Korean character set controversy, Tae-Jin Kang, Jun-Hee Lee, and Ki-Seong Lee led the argument. Even though there were obvious differences between the double-byte Johap in the first Korean controversy and the variable-length combination of 240 Jamo proposal for DIS-2 10646, the combining

[8]The swap area was also to enable existing national standard encoded in separate national planes, such as Chinese, Japanese, and Korean (JTC1/SC2/WG2 1991).

[9]According to this proposal, 2,350 Hangul syllables should remain temporarily for compatibility reason with current practices.

of three 5-bit in Johap and the conjoining of three 16-bit Unicode was seen as the basically same approach to Korean script encoding. The second proposal were thought to produce similar results as Johap, that is, the realisation of all modern and old Korean in character encoding (Kang 1992, Lee 1992*b*, Lee 1992*a*, Korean JTC1/SC2/WG2 1992*b*).

The proposal three and four accepted the practical mixture. The former recommended that the Korean encoding should use 2,350 Hangul syllables from KSC 5601:1987 as a primary source and the combination of 240 Jamo for the rest of modern Korean and old Korean. The fourth proposal includes the additional 1,930 modern Hangul syllable from KSC 5657:1991 on top of the 2,350 Hangul syllables (preferably rearranged in alphabetical order) with the 240 Jamo to encode old Hangul syllables and 6,892 excluded modern Hangul syllable. Proponents of the syllable oriented encoding method argued that first, encoding a Hangul syllable in one 16-bit Unicode is more efficient way of Korean encoding than conjoining method. Second, current national standards, KSC 5601:1991 and KSC 5657:1991 included almost all Hangul syllables in use, and its inclusion into the BMP of DIS-2 10646 would provide a reasonable solution. Third, the radical overhaul of the Korean repertoire with the new 240 Jamo would not be a practical solution, because it would disturb common practices and collaboration with the JTC1/SC2/WG2. Supporters of the proposal three and four came from researchers or officials from governments or academics involved in previous or current government funded standard projects. At the 6th Korea JTC1 SC2/WG2 meeting, the members voted on the proposal to decide which proposal would be backed if the first choice were to be rejected by the ISO/IEC JTC1 SC2, and chose the second proposal against the fourth by 8 to 4 in the final vote (Korean JTC1/SC2/WG2 1992*a*, Korean JTC1/SC2/WG2 1992*b*).

The recommendation went through the deliberation of Korean JTC1/SC2/WG2 in April and May, and the position of Korean JTC1 on the DIS2 10646 was finalised that 'Republic of Korea (Korean Bureau of Standards) votes YES with editorial comments,' requiring fives changes to be made. Below is the summary of five requests:

1. Replace the Hangul Jamo and Combining Hangul Jamo with a new set of Hangul Jamo.
2. Replace Clause 23.4 (Combining Hangul Jamo) of DIS with a new Jamo combining method.
3. Hangul Jamo combining method should be supported in implementation level 1.
4. Kugyol characters (ancient Korean syllabary) should be added to the BMP.
5. Withdraw 5,953 precomposed Hangul syllables from the BMP and allocate enough contiguous space in the BMP to represent 11,172 precomposed modern Korean syllables.

It continues;

> We feel that our proposals 1 through 4 can be accommodated without major changes to the current DIS. If these proposals are not accepted, our vote will change to NO. If proposal 5 is not acceptable, we propose to withdraw the Supplementary Hangul and Old Hangul precomposed syllables from the BMP and leave the 2,350 precomposed syllables from a widespread industry standard (KSC 5601) for requirements of compatibility. If this is not acceptable, our vote will change to NO (Korean JTC1 1992*a*).
>
> Therefore, it was conditional 'YES' vote in order to lead the JTC1 to accept the Korean proposal one or at least the proposal two the future Korean repertoire in the new international standard. The result of the ballot in May was an approval of DIS-2 10646. The requirement to approve DIS was to have not less than 2/3 of participating members voting the YES and not more than 1/4 of all members voting NO. YES votes counted 20 out of 24 participating members, and 6 out of 30 voting members (JTC1/SC2/WG2 1992*a*).

Korean delegation participated in the 22nd JTC1/SC2/WG2 meeting with the objectives set up in the Korean position above. However, one week long negotiation among delegations from 14 member countries[10] produced an unexpected result in terms of Korean repertoire change. According to the plan of Korean delegation, their ultimate objective was to incorporate 11,172 modern Hangul syllables and 240 Jamo in BMP (first proposal from Korean JTC1/SC2/WG2), if this was unlikely, then try to delay the finalisation of the DIS-2 10646 in order to earn

[10] In alphabetical order: Canada, China, Denmark, Egypt, France, Germany, Greece, Israel, Japan, Korea, Poland, Turkey, U.K., U.S.A.

Year	UCS/Unicode	Hangul Syllable		Hangul Jamo	
		Modern	Old	Jamo	Compatibility
1989	DP 10646	2,350			
1990	DIS-1 10646	2,350			
1991	Unicode 1.0	2,350			
1991	DIS-2 10646	4,280	1,673	94	
1993	IS 10646-1:1993	6,656	0	240	51
1993	Unicode 1.1	6,656	0	240	51
1995	IS 10646-1:1995	11,172	0	240	51
1995	Unicode 2.0	11,172	0	240	51

Table 7.2: Korean script in UCS and Unicode

more time to persuade other member states, if this was unfeasible, then insert 240 Jamo and removed all modern and old Hangul syllables except for 2,350 from the KSC 5601 for compatibility reason (Korea JTC1/SC2/WG2 1992). In the meeting, the Korean delegation argued that the inclusion of 11,172 Hangul syllable was extremely important both culturally and practically, and it was also necessary for the stability of the future Korean repertoire in the national standard. However, the representatives of China and U.S.A strongly opposed to the proposal. China wanted to preserve as much code space as possible in BMP to move additional Chinese character in swap area into the unified CJK ideograph area. U.S.A was against any major change in later stage of ratification which would disrupt the harmonisation with the Unicode. Negotiations between the parties resulted in a compromise. JTC1/SC2/WG2 decided to that the BMP would include the new 240 Jamo as Korea wanted, but only 2,376 additional Hangul syllable instead of including all 11,172 modern Hangul syllable. Therefore, the UCS would have 240 Jamo and 6,656 Modern Hangul syllable (JTC1/SC2/WG2 1992*b*). In terms of the size of Korean repertoire, this was largest codespace ever allocated to Korean script in any international standard, but in terms of structure, ironically, this was similar to the least favoured option from the Korean JTC1 SC2/WG2 meetings before the Seoul conference. It was complex and insufficient, for the Hangul syllable was scattered in three separate blocks. After editing period to incorporated negotiated changes, the ISO/IEC 10646-1:1993 was published in May 1993. The next month, the updated Unicode version 1.1 was also published with the harmonised repertoire with the 10646.

7.4 Korean repertoire in ISO/IEC 10646-1:1995

From the 24th meeting of JTC1/SC2/WG2 in Washington, DC, USA in November 1993, a new effort has been made to build the ISO/IEC 10646 more implementable by defining full architectural structure in detail. The way in which the BMP should operate with other planes had not clearly defined yet. Apart from the original design of UCS-2 and UCS-4, a new design of UCS-2E was proposed as a new architecture of the UCS to deal with more characters than 65,536 allocated in BMP. The discussion over the new architecture also created a room for the repertoire change, and this was seen to the Korean JTC1 as the last chance to raise the issue of Korean repertoire in the UCS and Unicode, the inclusion of all 11,172 precomposed Hangul syllable. For the incorporation of Johap character set into the national standard KSC 5601:1992 had not affected the market practices of the industry in general, and in particular, in system software level, there always had been a strong motivation to include the rest of 4,516 Hangul syllable in the BMP, which was denied in 1992.

At the same time, the Microsoft Korea reached at the similar conclusion.[11] For the company to avoid the chronic problem of costly localisation process of system and applications software in the future, the UCS and Unicode were seen as the only feasible solution. However, anything less than full support of all modern Hangul syllable in the UCS and Unicode would undermine the long term prospect of the company in Korean market, for the partial support of Korean script would be vulnerable to criticism and could be exploited by competitors. Before the end of 1994, the Microsoft Korea and Haansoft, the two archrivals in

[11] Interview with Sang-Kyu Ahn, 8 August 2000.

Korean word-processor market, decided to cooperate each other, and formed a united front with the Korea JTC1 to achieve a common goal through the Unicode consortium and the ISO/IEC JTC1.

In the Unicode Technical Committee in March 1995, the active participation of the Haansoft Inc. and its alliance with Microsoft (through the mediation of Microsoft Korea) formed a force behind the overhaul of the Korean Hangul syllable repertoire in Unicode. It changed from total 6,656 Hangul syllables in three separate blocks of BMP to total 11,172 full repertoire in one contiguous code space. In three years time, the position of the Microsoft shifted from the strong opposition to any change to the wholehearted support for the large Korean repertoire:

> In 1995, the situation changed towards Unicode 2.0. New delegates from Microsoft had their objections scrapped after the cooperation with Microsoft Korea, and supported the Korean proposal to include the whole 11,172 modern Korean syllables and to reshuffle the part of BMP structure to have the Korean repertoire in one contiguous space in alphabetical order. Microsoft was adamant that it almost threatened to work out of Unicode consortium if this proposal would not taken seriously. After a ballot for the change, the result was favourable for the proposal by just one vote. If it had not been the active participation of Haansoft and its alliance with Microsoft, the change would have not faired so well. For the change of Korean repertoire, the Haansoft bought its full membership for the year after having been a liaison and cast an important yes vote for the 'historic' event[12]

Carrying the momentum of the success in the Unicode consortium, a month later, in the 27th JTC1 SC2 WG2 meeting in Geneva, Switzerland, the Korean delegation made a strong argument for the case. Despite the oppositions from China and Japan, the cooperation between Korean and U.S. delegation finally managed to include all 11,172 Hangul syllable in a contiguous code space in alphabetical order. Japan and China expressed their concerns that the Korean proposal would also requires forbidden 'depreciation (to be removed in next

[12] Interview with Tae-Jin Kang, 17 August 2000.

version),' rather than simple addition of the extra characters. Against the concern, Korean delegation argued that the current Korean repertoire would be a permanent source of problem and instability in the future, and only the addition of the rest of Hangul syllable in contiguous space would make the closed set of Korean repertoire, promising this would be final request in regards to the Hangul syllable repertoire. Also, it was stressed that the new Korean national standard KSC5601:1992 had already included all 11,172 Hangul syllables. U.S. delegation strongly supported the Korean position defending it against the argument of China and Japan that this would leave the precedent of depreciation and would lead to the instability of the whole BMP. U.S. delegation maintained that this was exceptional case, which 'addresses a grave problem in a particular script that has some historical problems (JTC1/SC2/WG2 1995).' As a result, ISO/IEC 10646-1:1995 and Unicode 2.0 (1995) emerged as a new international standards. In December 1995, Korean government recognised the new international character set standard, ISO/IEC 10646-1:1993 as a superset of the new Korean national coded-character-set standard, KSC 5700.

7.5 Conclusion

The chapter summarises the transformation of the international character set standard in terms of the overall structure and Korean repertoire within it. Growing demands for multi-lingual information processing and borderless information exchange had called for a truly international character set standard. However, the ISO 2022 extension rules failed to provide an adequate solution, and some industry initiatives for multi-lingual character set were tried without producing a widely accepted standard. Then, the international standardisation organisation in the field, ISO/IEC JTC1, succeeded in revitalising the UCS project in 1990, which had been stalled for years, and at the same time the Unicode consortium also successfully coordinated the efforts of many industry leaders to build a radically new 16-bit character set. A negotiated synchronisation between the two initiatives resulted in the ISO/IEC 10646-1:1993 and Unicode 1.1, and later versions, a series of new multi-lingual character set standard sets approved by both officialdom of ISO and industry leaders.

Korean repertoire in the new national standards went through a gradual enlargement process. The enlargement of Korean repertoire was achieved with the transformation of the design features within the UCS and Unicode. First, ISO/IEC JTC1 decided to keep the C0, C1 areas of ISO 2022 for the DIS 10646, and the decision shaped the major structural decision of KSC 5657 and the subsequent Korean repertoire enlargement in DIS 10646, from 2,350 to 4,280 modern Hangul syllable based on KSC 5657. Second, the negotiation for convergence between ISO 10646 and the Unicode released the new codespace in the BMP in ISO/IEC 10646-1:1993 and the Unicode 1.1, which allowed the inclusion of total 6,656 Hangul syllable. Third, the further structural changes of BMP made in 1995 made possible the inclusion of all 11,172 modern Hangul syllables and realignment of them in alphabetical order.

Instrumental in widening the Korean repertoire was the activities of Korean JTC1 SC2/WG2. As the political climate changed and the public pressure for transparency increased, the Korean standard bureau became more responsive to expertise outside government and more pro-active towards the international standard setting process. Korean experts technical committees, Korean JTC1 SC2/WG2, were founded and given the responsibility for leading the national standard setting and participating in the new international standards. The committee became the most prominent domestic experts forum where diverse experts opinions were discussed for the national standards setting and for more effective participation in the international standard fora. In particular, the committees played major role for coordinated efforts to enlarge and rearrange Korean repertoire in ISO/IEC 10646-1:1993/ Unicode 1.1 and ISO/IEC 10646-1:1995/ Unicode 2.0.

In a sense, the transformation of the international character set standard did affect the first phase of Korean controversy by constraining the structure of KSC 5657:1991. However, the UCS was in early stage of development at that time, and the reservation of control function area was more of the influence of ISO 2022 rather than the effect of the new standard. As a whole, the influence from the development of UCS and Unicode was minimal for the first phase of Korean controversy. On the other hand, the transformation had profound effects on the second phase of Korean controversy between 1995 and 2000 to be describe in the next chapter during which the ISO/IEC 10646-1:1995 became a national standard in Korea, and Unicode became a basic character set used by Windows operating system.

CHAPTER 8

Korean national standards controversy II: 1995-2000

The first stage of controversy described in the chapter 6 was characterised by the competition between the two rival character sets, Johap and Wansung, under the international standard regime of ISO 2022. At the second phase of the controversy during the period of 1992-2000, there were elements of continuation in the sense that there still were disagreements on the relative merits of Wansung and Johap, and the international standards regime played a crucial role in the Korean national standard setting process. However, the second phase of the controversy was also distinctive from the previous one on three important points. First, the controversy developed under a rapid transformation of international standards regime itself, from ISO 2022 to ISO/IEC 10646-1 and UCS. Second, the alliances which had consolidated towards the end of the first phase of the controversy were unmade and remade during the second phase. Key actors involved in both the Korean national and international standards frequently switched their strategies between the competitive and cooperative ones according to their changing needs. Third, the relationship between the national and international standardisation process had changed from a unilateral to bilateral one. Unlike the first stage during which the Korean standardisation process was unilaterally constrained by the rules of ISO 2022, Korean actors actively engaged in the design process of the UCS and Unicode as a government delegate or a member of the standards consortium.

Figure 8.1 shows the main Korean and International character set standards with emphases on the most relevant standards during the second phase of the controversy. Wansung and Johap, the two main Korean character set standards featured in the first phase of controversy, remained influential in the second phase. Under the dual standards system of KSC 5601:1992, the two standards continued to dominate the scene, as Wansung enjoyed the exclusive support from Microsoft Windows system software for years and Johap maintained its popularity in the word-processor and communications applications sectors. As described in the previous chapter, however, a new international standards regime emerged with the successful launch of ISO/IEC 10646-1:1993 and Unicode 1.1, offering a much more efficient means to deal with the internationalisation of software. The new trend later had led to the Microsoft's decision to deviate from the Korean national standards, KSC 5601:1992 and to adopt 'Extended Wansung' in Windows 95 Korean version, therefore triggering another round of public controversy in 1995. Further enlargement of Korean repertoire in ISO/IEC 10646-1:1995 and Unicode 2.0 then greatly improved the prospect of the new standards as an realistic alternative for the Korean national standard. The Korean government adopted the ISO/IEC 10646-1:1995 as Korean national standard, KSC 5700:1995. The figure 8.1 also hints the changing relation between the national and international standardisation arenas. Even though KSC 5657:1991 was a failure, it proved an important step for the future Korean standards setting, helping to enlarge the Korean repertoire in DIS-2 10646:1991. Then, the compromise solution of KSC 5601:1992 and the large repertoire of Extended Wansung later influenced the shaping up of the ISO 10646-1:1995 with full Hangul syllable repertoire and 240 Jamo elements.

Chapter 8 consists of four sections. The first section, 8.1, describes the continuing competition between Wansung and Johap in Korean software market since

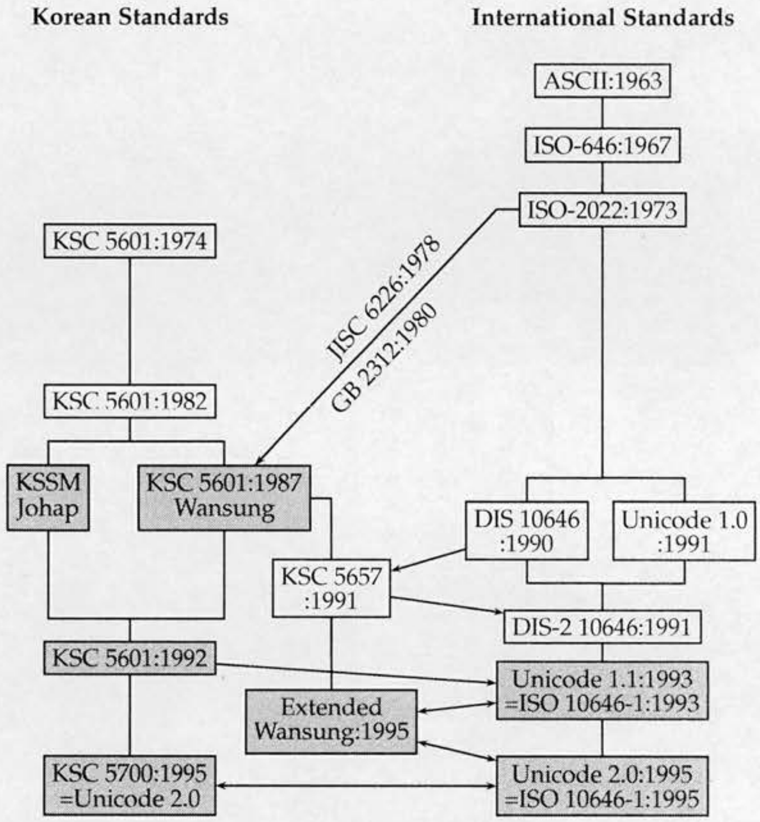


Figure 8.1: Korean and International Standards

1992 with particular interest on the word processor applications sector. With the enactment of KSC 5601:1992, granting both character set standards equal legal status, the legal and policy issues around the character set standards disappeared, and the centre of attention moved from the realm of standard bureau and advisory committee to the software market where the contested technological properties of the two character sets would be judged by developers and users. In terms of the competition between the two in the software market, the most significant battle was waged in a contest between the two word-processor applications, Haansoft's HWP and Microsoft's Word. The contest had the characteristics of a proxy war between the character sets standards, for the Word and HWP encoded document file with the Wansung and Johap character sets respectively, and this had significant implications for setting 'de facto' character set standards. Section 8.2 introduces a return to the public and antagonistic controversy over the character set issue in 1995, when the Microsoft Korea unveiled a new proprietary character set, 'Extended Wansung,' as a base character set for the forthcoming operating system, Windows 95 Korean version. It was an unexpected turn of event, for the former adversaries within the Korean SC2/WG2 and rival companies had cooperated for the enlargement of Korean repertoire in the new international standards, ISO/IEC 10646-1 and Unicode and thus seemed to create a consensus towards the new international standards. Moreover, Microsoft had made public just six months before that it would incorporate Johap in the upcoming system software. The Microsoft's change of policy not only frustrated Johap supporters in public and industry but also upset the government because it was a deviation from both existing (KSC 5601:1992) and upcoming (KSC 5700:1995) national standards. The decision led to a return of public controversy over the Korean character set standardisation. Section 8.3 looks into the situation towards the end of the 1990s and the controversial attempt of Microsoft to force out its rival word-processor, HWP, from market in exchange for capital investment to Haansoft, financially troubled developer of HWP, amid the Asian financial crisis. There ensued an unprecedented public outcry, and various campaign groups quickly emerged in order to safeguard the future of HWP against Microsoft's threat. Successful mobilisation of support and resources forced the Haansoft to abandon the original deal with Microsoft and take a counter-bid from the campaign groups. The survival of the HWP had significant implications for the fate of Johap standard, because HWP was the only viable word-processor applications using Johap as its basic character set. The section 8.4 describes what followed the events in 1998, a sea change in character set standards support in the systems and applications software market in Korea and the closure of the controversy. Despites the extraordinary level of popularity and public support enjoyed by Johap character set and HWP word-processor, in 2000, Haansoft decided to abandon Johap and replace it with Unicode as the basic character set for its new line of word-processor replacing HWP. Windows, a virtual monopoly in the personal computer system software, began to fully support Unicode and all major word-processor switched to Unicode, the 15 years of character set standards controversy came to a closure with the Unicode as a new consensus.

8.1 Continuing competition between Johap vs. Wansung

When the public controversy over the Korean national character set standards resulted in the dual standards system, acknowledging both Wansung and Johap as national standards, it marked an end of an era. At government level of standard bureau and advisory committee, the dispute over the national character set standards had disappeared for the first time since the mid-1980s. Having chosen a compromise of the dual standards system, the Korean government became an impartial player over the character set standardisation issue, as far as the rivalry between the two prominent standards were concerned. Therefore, in a sense, the contest between the character set standardisation seems to have come full circle, reminiscent of the situation before 1987. With the equal legal status and no preferential procurement specifications, developers and users were left again to decide which character set standards to support and use in its own merits.

Considering the impacts of the National standards, KSC 5601:1987, in the past,[1] it seemed that the amendment was likely to have significant positive effects on the prospect of Johap. However, the optimism was short-lived. As the new national standard, KSC 5601:1992, was a dual standards system, compliance to either of the character sets could satisfy the procurement specifications. Bidders for government procurements of hardware equipments and software solutions, therefore, did not have to switch to Johap in order to be eligible, as long as it supported the existing Wansung standard. Despite its dramatic impact on the public controversy itself, the new standard simply did not have a visible impact

[1]The two most striking examples were the government procurement specifications for Administrative Computer Network Project and Educational Computer Project which required a national character sets standard support, and Microsoft Korea's decision to change its base character set for MS-DOS system software from Johap to Wansung. See the section 6.2 for more.

on the market choice of character set. A comment of an industry expert below sums up the situation:

> The actual achievement of 1992 dual national standard (incorporation of Johap) was that it effectively ended rather destructive and wasteful controversy, even though it didn't bring any real change in the market.[2]

The Wansung character set was already well-established in the market between 1987 and 1992 during which it enjoyed the sole national standard status. One of the critical factors for the entrenchment of Wansung was the Microsoft Korea's decision to change its basic character set from Johap to Wansung following the success of the Wansung national standards, KSC 5601:1987. Since the MS-DOS 4.0 Korean version marketed in 1990, all subsequent Korean versions of MS-DOS and Microsoft Windows operating systems supported only the Wansung character set among the two, leaving Johap-based applications without system level support for Input/Output functions. Given the monopolistic position of Microsoft in the personal computer system software market, this meant that the Wansung based solutions secured a crucial advantage over those based on Johap. In a short period of time, the decisions made by government standard bureau and Microsoft Korea effectively set Wansung as a dominant character set standard in Korea. Therefore, the impact from the new amendment in 1992 was minimal apart from the disappearance of public controversy, and the overall domination of Wansung remained unchanged apart from a few niche applications software market. The entrenchment of the Wansung national standard, KSC 5601:1987 appeared solid:

> Enactment of 1992 dual standard was not successful in terms of market response. It was too late to change the tide. The market was already dominated by the system and applications software designed for the national standard (thanks to the Government National Information Infrastructure project), and it must have been too costly for firms to change its products to support the Johap as well as Wansung character set when there was no overriding demand for the former, which might compensate

[2]Interview with Jun-Hee Lee, 16 August 2000.

> the costs. Standard does not change easily just because there is an alternative with relative merits or there are some flaws in the current standard. A standard tend to be adopted by developers and users alike for the sake of its being a standard, and when it's adopted and widely used, it develops a formidable resistance due to its sunk investment. Ironically, this was the one of main reasons many people wanted to have Johap as national standard, because Wansung standard with its fatal limitation of 2,350 Hangul syllables would become more and more difficult to change as time goes by.[3]

Despite the disadvantage, the merit of using the Johap character set was apparent in certain areas of applications. For it supported the full repertoire of 11,172 Hangul syllables as well as Old Korean, Johap maintained its popularity in applications requiring a large repertoire of Hangul syllables and complex editing, such as, word-processors and on-line communications programs. As was explained in the section 5.2, some Korean software developers decided to include necessary Korean Input/Output libraries within applications and internally process these functions in order to overcome the limitations of system level Korean Input/Output support in the late 1980s. For the applications had their own proprietary Input/Output libraries, they could use other character sets than those supported by the system software or dedicated hardware. This line of development in applications software, thus, provided a means to use the Johap character set on Wansung based system software environment. Word-processor applications, such as, 'Hangul 2000', 'Barungul', 'HWP' and on-line communications programs, such as 'In-Rok', 'Tarurung', 'Iyagi' were the examples of this kind. They became popular choices of the users who wanted to use Hangul syllables beyond the confines of 2,350 allowed by Wansung (Lee & Jung 1991, pp.42-43). Although this is a limited range of applications, the word-processor was one of the most widely used applications in the personal computer applications market, and the Johap standard could compete against Wansung almost on equal terms.

[3]Interview with Sang-Hoon Jun, 31 July 2000.

Above all, the single most influential application based on the Johap character set was HWP, a Korean word-processor application originally developed by a group of university students. Launched in 1989 as freeware, it quickly became the most popular Korean word-processor among personal computer users, as some of the original developers founded a software company, Haansoft Ltd., and commercialised the program in 1990. The sales figures of the HWP shows the phenomenal success of the program, starting from 50 million won in 1990, to 1 billion, 2.2 billion, to 13 billion won in 1991, 1992, and 1993 respectively (Kim 2003, p.415). There were many factors explaining the extraordinary success of HWP, and three reasons were found most prominent; first, the proprietary standards strategy of main computer manufacturers in the 1980's, second, the peculiar market structure of personal computers in the booming 1980's, and the third, the use of Johap character and thus powerful Korean Input/Output support in HWP.

First, one of the distinctive features of the HWP, when it was compared with the other products already available in 1989, was that it could run on any IBM clone. Until then, most Korean computer companies designed word-processor in a way that it could operate properly only on the machines of their own brands. Before the national character set standard firmly established itself in the market, Korean computer manufacturers had been using proprietary Korean character sets, and the software applications bundled with the sales of hardware were tied to the proprietary character sets of the companies. Though this competitive strategy resulted in a serious problem of incompatibility, the proprietary standards had been favoured by manufacturers in order to reinforce the market position of their products. HWP was free from the incompatibility problem by using its own Input/Output libraries working independently from the manufacture's proprietary character set. This approach was tried by earlier word-processors, such as, 'Barungul,' in 1986 and 'Hangul 2000,' in 1988, but HWP was the first of its kind sophisticated and robust enough to compete in the word-processor market (Lee & Jung 1991).

Second, the two-tier structure of the personal computer market in Korea was another important contributor to the success of HWP. Outside the official outlets of major computer manufactures, there was a popular specialist arcade for electronic and electric goods in the centre of Seoul, the Capital. A part of the arcade were filled with small independent companies specialising in personal computer sales. These companies mainly imported foreign computer parts, assembled them into personal computer systems and sold them to consumers. The main attraction of these companies was unrivalled flexibility, catering for a variety of demands from individual buyers. Customers could choose any combination of available parts according to their needs and budget. Whereas large organisations preferred standardised goods and reliable after-sales services, many individual buyers chose the flexibility under low budget. During the personal computer boom in Korea from the mid-1980s, these small companies became very popular for the sales of customised personal computers. Moreover, these small manufacturers cum retailers had no vested interests in specific manufacturers or bundled software. They offered the buyers with a rich assortment of illegal copies of software in order to compete with the bundled software and service-network provided by big manufacturers. HWP quickly became one of the most popular 'gifts' installed on those computers. Therefore, the Korean copyright practices of the late 1980s and early 1990s was both a source of phenomenal success of the HWP and a cause for concern for the company, Haansoft Ltd. On one hand, the widespread practices of illegal copy undermined the profitability of the application,[4] but on the other hand, it also helped HWP to quickly build its installed base.[5]

[4] As some commentators concurred, Haansoft, always emphasised the damage incurred by the illegal trade and later defended its unpopular deal with Microsoft in 1998 on the basis of low profitability of HWP.

[5] HWP did not have complex anti-copy measures, and the inadequate anti-copy protection of HWP was a noticeable contrast to, for example, that of 'Sa-Im-Dang,' one of its competitor, which was

The third and most consistent reason for HWP's success was that it adopted the Johap character set so that it enabled users to access very large repertoire of Korean Hangul syllables, 11,172 modern as well as most of old Hangul syllables. Word-processor using the Wansung character set could only allowed the limited repertoire of 2,350 Hangul syllables until the KSC 5657:1991 extended the repertoire of national character set standard. However, the additional repertoire by the KSC 5657:1991, 1,930 modern and 1,754 old Hangul syllables, was not implemented by industry, leaving the applications based on the Wansung character set poorly supported in terms of Korean Hangul syllable repertoire. Although Johap could cause a data corruption problem during an international information exchange, this did not concern the majority of Korean word-processor users who were more interested in processing, storing, and exchanging Korean data among other personal computer users within Korea. For many users and developers of personal computers, the international compatibility was not a pressing concern.

> ISO 2022 was a standard for international information exchange, so it could be ignored if we have a large enough domestic market.[6]

> I was not convinced about the need for the ISO 2022 conformance of a domestic character set standard. A simple conversion filter could have done the work. Character coded set for internal use could have been effectively separated from the international communications. But the attempts to abolish KSC 5842 which requires the compliance to KSC 5601:1987 for government procurement specifications was not successful, for many of hardware and software firms at the time seemed to favour the ISO 2022 conformant standard because of convenience of font development and sunk investment made for the conformance.[7]

All three major reasons had contributed to the success of HWP in the early 1990s. Towards the mid-1990s, however, the impacts of the first two factors became less important than the third one. First, the Korean Input/Output solutions for personal computers became more standardised around the KSC 5601:1987

heavily protected by the limitation on the number of installation (Interview with Won-Sun Lim 22 July 2000).

[6] Interview with Jun-Hee Lee, 16 August 2000.

[7] Interview with Heung-Kyu Kim, 1 August 2000.

with the support of MS-DOS and Windows Korean versions. Computer manufacturers and specialised software developers in Korea began to produce new word-processors or update the existing ones tailored for the national standard character set. Second, the copyright protection in Korean had been steadily improved by the combined efforts of government and industry spurred by international pressure from the mid-1980s. Since the copyright protection became a source of trade issue between Korean and U.S. government in 1984, Korean government strengthened existing copyright law and introduced Computer Program Protection Law in 1986 (Lee 1998). From 1990, the Korean software industry began close cooperation with BSA (Business Software Alliance) and SPC (Korea Software Property-Right Council), and campaigned aggressively against copyright infringement (Kim 2003).[8]

Due to its strong performance in the Korean word-processor market, HWP became virtually the only and the most prominent champion for the Johap character set. However, the dominance of HWP did not go unchallenged for long, as Microsoft Word arrived at the Korean word-processor market and gradually increased its market share later. Soon after Microsoft Korea switched its character set standard to Wansung in May 1990, it launched the Korean version Excel spreadsheet program in September with a resounding success, quickly creating its customer base in profitable organisational market. Two years later, in September 1992, Microsoft Korea introduced Microsoft Word 1.2 Korean version, starting a fierce competition with HWP for the Korean word-processor market. Still, Microsoft Word started and remained as a junior competitor against the near monopoly of established HWP, but the trend began to change with the development of the Microsoft Windows system software. One year after the success of Windows 3.1 in U.S. market, the Microsoft introduced the Windows 3.1 Korean version in May 1993. The huge success of Windows 3.1 Korean version

[8]The copyright infringement in Korea has been more widespread than many of development countries. In 1997, for example, the illegal copies constituted 67 per cents of software used, compared to the much lower estimates of 32 per cents and 27 per cents in Japan and U.S. respectively (Shin & Park 1999).

transformed the personal computer applications software environment into a new one based on Windows APIs, and this provided a great advantage to the Windows-based applications over the DOS-based ones. Whereas the Microsoft quickly ported Word to the Windows environment and able to use the various functions of Windows APIs including the Input/Output libraries, the Haansoft had to develop a new set of Input/Output libraries for HWP to use the Johap character set within the new Windows environment. While HWP always had had the extra burden of maintaining proprietary Input/Output libraries under the MS-DOS environment since 1990, the equivalent job under the Windows environment required more resources and time, due to the complex nature of the Windows system software environment. The burden of using unsupported character set was growing.

> When MS-DOS was the main operating system, the extra burden for maintaining Korean Input/Outout system at application level was relatively light, for operating system at the time did not provide many functions. But its costs and workload began to increase rapidly when HWP had to adapt itself to the Windows environment. Due to its different character set type and applications level Input/Output processing, HWP could not utilize many of newly provided resources from Windows APIs, and it had to include those functions within itself. This became an increasingly serious obstacle for the development of HWP.[9]

The first Windows based HWP appeared as late as in 1995. With the rapid growth of Microsoft Word, the Korean word-processor market became divided by the two main competitors, HWP of Haansoft and Word of Microsoft. For each of the two most prominent word-processors was based on Johap and Wansung respectively, it seems that the competition between the two character set standards after the KSC 5601:1992 was fought by the two proxies, the main implementers of each character set in the Korean word-processor market (Kim 2003, p.416).

[9]Interview with Sang-Hoon Jun, 31 July 2000.

8.2 The revival of controversy: Windows 95 and Extended Wansung

As described in the chapter 6, two factors were behind the unusual level of public interests in the technical standard setting process. First, the choice on character set between Wansung and Johap affected the experience of personal computer users in fundamental way. In particular, the national standard of KSC 5601:1987 imposed a strict limitation on the usage of Korean language in computing environment. Second, the standardisation processes of 1987 and 1991, many critics believed, were democratically unaccountable, and the national standard, in particular, the KSC 5601:1987 was forcefully implemented by the legislation without due consideration into the sensitiveness of the issue.[10] After the new national standard, KSC 5601:1992 acknowledged the Johap character set standard as a part of dual national standards in 1992, therefore, the two main issues seemed to be addressed and the public controversy quickly subsided. As described in the previous section, the competition between the two character set standards continued but in terms of the competition between products implementing those two character set standards. With the impartiality of the government and standards bureau guaranteed, the issue of the character set standards became a matter of consumer choice in the market rather than a subject of public controversy in public arena. The success of and the competition between HWP and Microsoft Word in the market seemed to reflect and serve the interests of different user groups equally well. Moreover, the rival companies in the industry and the former adversaries within the advisory committee had developed a cooperative relationship under the auspice of newly formed Korean SC2/WG2 from 1991 in order to achieve a common goal of Korean repertoire enlargement in the UCS and Unicode. In early 1995, the possibility of returning to an emotionally charged controversy seemed remote. However, a new controversy emerged in 1995.

[10]KSC 5842, a government set personal computer specifications, provided the grounds for discriminating against the Johap in government procurement policy.

Approaching 1995, the Microsoft's system software had been enjoying a virtual monopoly with MS-DOS series and Windows 3.1, and these operating systems from Microsoft had supported only the Wansung standard since 1990, providing the Wansung national standard a decisive advantage over Johap. Immediately after Johap obtained the national standard status in the 1992 amendment, the Microsoft was not persuaded to change its basic character set into or to provide system level support for Johap. However, the Microsoft finally yielded to the mounting pressure from the Johap supporters and announced on October 1994[11] that they would incorporate the Johap standard in Windows 95 Korean version. It was a long awaited piece of news for those who rallied behind the Johap character set for years, for the Microsoft's decision, if implemented, means that developers would be able to write and maintain cheaper and slimmer Johap-based applications using a set of Johap-enabled Windows APIs, making available all 11,172 modern Hangul syllables and many old Hangul syllables without extra burden of proprietary libraries.

However, the high expectation of Johap supporters turned into a disappointment in May 1995, when the Microsoft Korea annulled its promise and revealed a new proprietary Korean character set for the Windows 95 Korean version, called 'Extended Wansung Code System.'[12] 'Extended Wansung Code System had the features of a hybrid solution between the existing Wansung standard and the Unicode standard. It maintained 2,350 Hangul syllables in the same code space as in the Wansung standard, but added the rest of 8,822 Hangul syllables arranged in alphabetical order in separate space. Therefore, Extended Wansung was backward compatible with the most common Korean character set implementation, the KSC 5601:1987, and also it could provide the users with all 11,172 Hangul syllables. Microsoft Korea explained the background of its policy change

[11] A press conference given by Microsoft Korean on 18 May 1995.

[12] Microsoft soon announced change of name from 'Extended Wansung Code System' to 'Unified Hangul Code System', for the term 'Wansung' had been commonly associated with the limited repertoire of previous Wansung national standard. Both names have been used interchangeably by media since.

in the press conference that the company invested considerable efforts to incorporate Johap as it had promised to users, and in fact, it developed most of solutions based on Johap already in March 1995, but it was forced to abandon the project due to the problem of incompatibility and the difficulties involved in maintaining dual character sets both at system and applications levels.

The announcement of Extended Wansung drew mixed responses from the experts and users communities with the majority takinga critical stance. A few commentators cautiously welcomed the new character set, for it, for the first time, would enable the usage of all Hangul syllables under Windows environment, and could lead to the unification of the current dual character set standards system. However, others raised concerns mainly about the complex nature of the new character set and the way Microsoft handled the character set standard issue (Seo 1995, Yu 1995). Immediately, critics began to publicise the issue in newspapers and specialised magazines (Chang 1995, Park 1995, Yang 1995), and they also opened and organised discussion groups in on-line communities.[13] Critics converged on two main points as below:

First, the design of new character set was a technically inferior patch-work with only a short term prospect. Even though the character set could cover the entire repertoire of 11,172, the code space for them was divided into two separate blocks, which would complicated the data processing. The arrangement of 11,172 Hangul syllables in contiguous space was the main objective of the Korean delegation when it negotiated the terms in the JTC1 and Unicode consortium in 1995. For many critics, it seemed pointless to have all 11,172 Hangul syllables in wrong order in the new character set after what they achieved through years of struggle. Critics also pointed out that given the new Korean repertoire has been approved in Unicode technical committee, the 'Extended Wansung' would be a mere short term solution, causing unnecessary confusion and wasting resource for applications developers (Chang 1995).

[13] Two internet service providers, Hitel and Naunuri, became centres of the on-line campaign from August onwards.

Second, critics were bewildered by the way in which Microsoft Korea handled the issue of character set standards. Because of the monopolistic position of Microsoft in system software market, the decision of Microsoft was likely to have an enormous impact on the Korean character encoding. Therefore, Microsoft Korea was expected to be more transparent and responsive to the national context of the character set issue. Critics argued that the company lost touch with the user demands and disregarded the collective efforts to establish the best national character set in the long run. Academics joined the critics, expressing their concerns that the national character set standard should be decided not on the basis of a short term commercial strategy of a private company, but on the ground of broad-based consensus which could guarantee the long term prospect of the character set standards regime and the efficient Korean data processing system.[14]

Breaking silence between May and August, the government began to exert pressure on Microsoft. Ministry of Information and Communication announced on 18 September that it recommended that the government should suspend the purchase of Windows 95 Korean version and it would request Microsoft Korea to reconsider its character set policy in line with the new international standard, Unicode 2.0 and ISO/IEC 10646-1:1995 or the existing national standard, KSC 5601.[15] The Ministry also invited experts from government agencies and industry to a forum, where most of the participating experts concurred with the position of the Ministry on the issue, arguing for the use of national or international standard instead of the proprietary standard by the Microsoft.[16]

Facing the hostile reactions from the public and the strong recommendation from the government and the industry, the Microsoft made a U-turn on its character set standards policy for the new operating system in the experts forum,

[14]Interview given to a newspaper, ETNews on 10 June 1995 by Kyung Seok Kim, and Jung Young Byun, the two most prominent academics involved in the Korean character set standardisation.

[15]ETNews, 19 September, 1995.

[16]Representatives came from Ministry of Information and Communication, Industrial Advancement Administration, Ministry of Culture, National Computerisation Agency, System Engineering Centre, Software Industry Association, Haansoft, and Microsoft.

saying the company would seriously consider the demands of the forum and would announce its position as soon as possible. On 21 September, the president of Microsoft Korea explained its position that the company would develop a Unicode based Windows 95 Korean version on condition that ISO accepted the decision of Unicode Technical Committee, that is, the incorporation of 11,172 Hangul syllable in contiguous space in alphabetical order, and the Korean government recognised the resulting ISO/IEC 10646-1 as a new national standard.[17] Meanwhile, he added, the Microsoft would support the existing KSC 5601 rather than the new Extended Wansung in the currently developing Korean version Windows 95 which would be launched later that year. It seemed that Microsoft finally yielded to the pressure against 'Extended Wansung' after four months from its initial announcement. However, the Microsoft again changed its stance on the issue at the last moment, and announced on 3 November that it decided to maintain Extended Wansung but block the input of 8,822 newly added characters in order to remain compatible with the existing standard, KSC 5601. On 28 December, the Windows 95 Korean version was launched with Extended Wansung, with the extended area of 8,222 code points blocked from being invoked by users.

Already frustrated with the original design of Extended Wansung, some of the critics were angered by the last minute change made by Microsoft Korea, and organised street protest in front of the Korean Exposition Centre where the Microsoft was holding its Korean version Windows 95 launching ceremony. The protest was organised by four individuals actively engaged in the on-line discussions on the issue. Those were not well known public figures, and the size of the protest was small compared to the series of protests organised during 1991-1992 period, but the protest demonstrated the sensitivity of the character set standards issue and helped to raise the issue on the public agenda again for the first time since the end of the first public controversy (Gil 1996).

[17] ETNews, 22 September 1995.

Uncomfortable relation between Microsoft Korea and critics including the Korean government, however, dissolved in December. The Industrial Advancement Administration announced a new national standard, KSC 5700, which was the Korean subset of ISO/IEC 10646-1:1995 and included all 11,172 modern Korean Hangul syllables and the 240 Jamo for combining method for modern or old Korean. The government had long been preparing for the standardising national character set according to the new international standards regime,[18] and it accepted the new Korean repertoire of 11,172 Hangul syllables and 240 Jamo as the new Korean standard, as soon as JTC1 and Unicode consortium had passed them as the new international standards. The government also added that it would phase out the current standard, KSC 5601:1987, as the new standards were widely implemented. Less than a week, the Microsoft Korea also announced that it would support the new national standard and would incorporate the new standard in all operating systems and applications under development in the company. The controversy on Extended Wansung was effectively over at this stage. It was implemented in only one system software, Windows 95 Korean version, with the input of new 8,822 characters blocked. For that matter, Windows 95 Korean version operated as if it used the existing standard, KSC 5601:1987, even though it used Extended Wansung internally. At the end of 1995, even the blocked mode of Extended Wansung was dropped, and Windows 98 was built with the new standard, KSC 5700:1995.

8.3 The public controversy over the Microsoft's attempt on HWP

Even though the complete Hangul syllable repertoire and 240 Jamo were included in the new international character set standard, ISO/IEC 10646-1:1995 and Unicode 2.0, the new standards were yet to materialise their potential in Korean character encoding until 1998. Crucial for the delayed implementation of

[18] Active involvement in the JTC1/SC2/WG2 and a series of government-funded studies on the new standard were based on the prospect of Korean character set standardisation on ISO/IEC 10646-1 and Unicode (National Computerisation Agency, 1991;1993;1997, Ministry of Culture, 1997).

the new standards was that the Microsoft had not fully integrated the new standards in their Windows system software until later 1998. Microsoft had chose 'Extended Wansung' as the interim character set solution which bridged the previously dominant standard of KSC 5601:1987 and future solution of Unicode in Windows 95. Under the absence of system level support for the new standards, the status quo between Wansung and Johap remained. Wansung was the basic character set of Windows environment due to the backward compatibility of the 'Extended Wansung' of Windows 95, and Johap was still popular in the document encoding due to the strong performance of the HWP in the word-processor market. There was no significant change of circumstances around the Korean character set standards immediately after the 1995. In 1998, however, the word-processor application, HWP, became a centre of public controversy, when Microsoft attempted to force out the HWP from the market in return for the urgently needed investment, Haansoft Inc., the developer of HWP, in the middle of Asian financial crisis. The proposed deal between Microsoft and Haansoft, the conditions on which the investment was promised, did not directly concern the character set standards. However, the turn of event had an important bearing on the character set issue. For HWP was the sole champion of Johap, its disappearance from market would inevitably mean no more influential applications to support Johap character set and the convergence of Korean character set standards on Wansung as long as the competition between the two character were concerned.

Towards 1998, the Korean word-processor market was dominated by two major competitors and one minor player; the HWP of Haansoft, the Word of Microsoft, and HunMinJungEum of Samsung, one of the largest conglomerates in Korea. Even though the HWP has maintained the largest market share since 1990, the Microsoft Word had been increasing its market share with the success of Office suite, as the Windows 3.1 and Windows 95 became dominant system software environment of PC market. Also the Windows-based HunMinJungEum carved a small section of market, when the Haansoft hesitated to port HWP from a DOS to Windows environment during the period of 1993-1995.

Meanwhile, Haansoft began to expand its business from 1994, venturing into the fields of communication software, internet, education, and distribution network by acquiring other companies or establishing its own subsidiaries. In 1997, the Haansoft became a large software company in local standard with annual sales value of roughly 10 million pounds and with 200 employees. However, the company faced a series of crises from around 1995 and experienced a sharp downturn. The HWP faced a tough challenge by the Microsoft Word in the word-processor market, and some of the ambitious expansion plans turned out to be unsuccessful, undermining its profit base to an increasing extent. On top of the difficulties from overstretch and shrinking market share in word-processor market, the financial crisis in Indonesia had spread to the other part of Asia and made a devastating impact on Korean economy as a whole from 1997. The accumulated effects of these domestic and more global origins had exerted immense financial pressure on the Haansoft that it was forced to shed most of newly acquired assets and to reduce the number of employees down to the core 50 strong programmers and staffs by May 1998. While the company chairman blamed for the failure of the company on the Asian financial crisis and the widespread practices of illegal copy of its main product HWP,[19] many commentators were quick to point out the over-expansion, sluggish technical improvement of the HWP, and the late porting of HWP to Windows environment as main causes of the company's crisis, even though many of them agreed on the problem of copyright infringement.[20]

On 15 June 1998, the Microsoft Korea and Haansoft announced in a joint press conference that Microsoft would invest 20 million US dollars to Haansoft. The deal meant a crucial lifeline for the Haansoft under crisis, and also it was seen

[19] Haansoft and Korea Gallop surveyed 2,500 adults over 18 years old and reported that only 12.9% of users bought legal copy of word-processor applications (Microsoftware 1998, July, p.161).

[20] Microsoftware 1998, July.

to be a good news for the confidence of Korean economy as a whole, for it was badly in need of foreign investment at the peak of Asian financial crisis. However, the investment decision had attracted huge media attention not because of the prospect of much-awaited direct foreign investment but because of the condition attached to the investment. The letter of intent exchanged between the companies stipulated that there would be no management participation from Microsoft with the 19 per cent shares, however, Haansoft should concentrate on Internet-related business and cease to develop HWP further. The investment was in exchange of phasing out HWP from Korean word-processor market, the only viable competitor to Microsoft Word.

The news spread quickly through daily broadcasts and newspaper, later followed by weekly papers and specialised magazines. Media in general followed the story with great interests, closely monitoring the development of the deal and analysing the possible outcomes. The initial responses to the news were mainly disbelief and despair. The public in general and many in experts community had so much pride and affection in HWP that they were particularly shocked to realise that the Haansoft had struck a deal with the most fierce rival at the cost of users using HWP. The surprise of the many observers was complete due to the confidence shown by Haansoft and the growing anti-Microsoft sentiment at the time. On 15 May, the chairman of Haansoft, recently resigned from the post of Member of National Assembly, unveiled in a press conference three main strategies for maintaining the top market position of the HWP against the challenge of Microsoft. A marketing representative of Haansoft confidently dismissed the possibility of Microsoft's dominance in the Korean word-processor market. With the HWP being considered as a national champion of Korean software industry, Haansoft also could and had exploited the national pride in and patriotic sentiment for HWP against the backdrop of Microsoft's recent publicity fiascos. For examples, Microsoft Encyclopaedia, 'Encarta,' described a disputed island of 'Tok-do' as Japanese territory; Windows 98 beta Korean version had

Korean national flag upside-down; and a Microsoft simulation game set an early Korean kingdom in Manchuria as Japanese colony. Recovering from the shock, however, the direction of the discussion on the issue changed from an emotional blame game to a more reasoned analysis of the situation. Experts, business leaders, academics, and the public began to set up public forums to discuss the issue, and organised themselves for a search for the best solution. After almost seven years from the public controversy during 1991-1992 and three years from another controversy in 1995 with limited participation, the massive public mobilisation was to be organised again.

On-line communities quickly became the centres of public discussions over the issue. The number of subscribers to on-line services had reached at 5 million in 1998 (National Computerisation Agency, 2000). The growing on-line communities became a fertile ground for organising campaign groups on the issue by the members of the public. Within days, major on-line service networks, such as, Chollian, Hitel, Naunuri, and Unitel became crowed with the new discussion groups set up for the issue. Among those, the HWP users group and some active members of the new discussion groups appealed for the formation of a unified campaign centre on the network with resounding success. For example, on 23 of June, in a week from the initial announcement of the deal between the two companies, this on-line campaigners managed to collect petitions from more than 13,000 signatories, and secured the participations of 120 organisations under its banner. In a public statement, they urged the government to take active role to save HWP, and the campaigners appealed to the Microsoft and Haansoft to rescind the agreement. The main objectives of the campaign were to publicise the issue and to build up public pressure on the both companies with the backing of public opinion.

At the same time, a sector of business community with the leadership of the Korean Venture Business Association (KVBA) also responded to the campaign to save HWP from the threat of Microsoft. On 19 June, KVBA launched its own campaign asking for each of the estimated three million HWP users to donate ten thousand one (about 5 pounds) to Haansoft. It also requested the correspondent banks to extend its loan to Haansoft to easy the financial stress on the company. The basic strategy of the campaign group was to mobilise enough financial resource and offer Haansoft a counter investment bid on condition of the continued development of HWP, a opposite condition from the Microsoft's. On 22 June, a group of activists from KVBA and major on-line discussion groups formed a nationwide campaign group called 'Alliance for saving HWP', and began fundraising for counter-bid in honest. The logic behind KVBA's campaign was that the HWP was the best and the only word-processor application fully capable of expressing Korean language with its implementation of the Johap character set. Therefore, if the deal between the Haansoft and Microsoft proceeds as planned, it would mean not only the disappearance of HWP, a word-processor applications among many, but also the whole set of accumulated know-how and input/output libraries based on the Johap character set. Given the very competitive market with high barrier of entrance, it seemed very unlikely that a new Johap-based application would appear in Korean word-processor market within foreseeable future. Therefore, the campaigners argued, the loss of HWP would also mean the loss of essential tools for development of the most unique and cherished cultural heritage, Korean indigenous writing system, Hangul. They also contend that the migration from HWP to Microsoft Word would be costly and damaging at both social and economic levels, which would inevitably involve the loss of invaluable data, retraining, and higher prices for Microsoft Word in monopoly market.[21]

On the other hand, a group from on-line communities was behind a radical proposal of building an open-source HWP, an open source applications with the input/output libraries for Johap character set. Campaigners for 'Open HWP' project argued that the HWP became a public asset. Even though the programme

[21] Paper presented to the 'Forum for HWP and its alternatives' on 15 July 1998, hosted by Hankyorae newspaper and Korea YMCA.

has been created and developed by a commercial company, it owed its success to the society in general. Factors, such as, the investment made by users in terms of purchase and time spent on learning, accumulation of data on its format, invaluable feed-back of the large user base, it argued, all contributed to the extraordinary success of the application. Since the HWP became a common goods in this sense, it should be protected from the destructive exercise of exclusive ownership, whether it be Haansoft or Microsoft. They blamed reckless expansion of the company for its own demise and demanded a public ownership of HWP independent of its developer Haansoft. Advocates of the Open HWP project also promoted the open source approach for the further development of HWP, claiming that the source code of the programme should be opened up to the public and the open HWP project itself should be under control of a dedicated non-commercial organisation. In this vein, the Open HWP campaigners opposed the campaign of the Alliance for saving HWP, for it would only mean a change of ownership, which leave the fundamental problem unresolved, that is, the market control of social assets.[22]

A similar but more conventional approach was also made on the building of substitute application for HWP. A developer of computer peripherals, WASSO Ltd. showed its interest in developing a substitute application for HWP with former engineers of Haansoft. This would be an effort to create a commercial application equivalent of the HWP with no change of current business model of exclusive ownership of company by private company and control of the source code. The project, however, seemed to face some difficulties which would substantially delay the development process of substitute application. First of all, it could not secure any core programmer involved in the development of the HWP who had intimate knowledge of the major features of the application. Also, there was a possibility that the contract between the Haansoft and Microsoft might

[22]Paper presented to the 'Forum for HWP and its alternatives' on 15 July 1998.

have given Microsoft exclusive right on all resource developed by Haansoft including proprietary input/output libraries of the HWP. However the prospect of the project was significantly improved when a HTML editor developer, Namo Interactive Ltd., joined the force on 25 June 1998, for Namo Ltd., at the time had three of five core programmers who created or developed the HWP from 1989 to 1995. Under the new leadership of Namo Ltd., a group of engineers and entrepreneurs set up a task force, 'Namo Hangul,' in order to prepare for the launch of 'Korean Software Consortium (KSC)'. Another difference in the approaches of Open HWP project and Namo Hangul task force was that the latter had supported the campaign of Korean Venture Business Association and the efforts of 'Alliance for saving HWP' to save Haansoft. Namo Hangul project was proposed as a backup plan in case that the deal between the Haansoft and Microsoft proceed as planned and the effort to help Haansoft maintain the control of HWP would fail.

Meanwhile, the government was split on the issue. From early on, the Fair Trade Commission stated that it would investigate the case for the possible breach of anti-trust law,[23] but it had not produced a verdict until the whole controversy ended in mid-July. The Ministry of Information and Communication made clear its position on the issue on 22 June that the ministry was in favour of the Microsoft investment plan considering the nation's urgent needs of Direct Foreign Investment of Korean economy under the influence of Asian financial crisis, triggering a barrage of complaints from the parties working to save HWP. Unpopular it may have been among the public, the position of the Ministry was one of main, though not voiced, perspectives on the deal between the two companies. From this view point, the intervention from the public or government would lead to a distortion of market force.

> The financial trouble of Haansoft was caused by the mismanagement of the company, and therefore, arbitrary intervention of the public or the government in this

[23] ETNews 17 June 1998.

> matter will distort the efficiency of the market to the detriment of the future software industry as a whole. Moreover, Microsoft Korea would integrate the accumulated indigenous technologies of Haansoft and contribute to the development of multilingual system and applications software through further development of Korean version of Microsoft Word.[24]

However, this view was not shared by all government department. Reminiscent of its position during the 1991-1992 controversy, the Ministry of Culture expressed its concern on the possible loss of HWP. An official from the ministry commented,

> The loss of HWP poses a serious problem for representing old Korean, and it will have adverse effects on the language use and cultural life of the nation in general.[25]

On 6 July, the 'Alliance for saving HWP' held a press conference, and publicly announced its offer to Haansoft, revealing its plan to inject 10 billion won (approximately 5 million pounds at the exchange rate of the time) to save the company from imminent bankruptcy and invest further 10 billion won later to normalise the company. Under the new offer, Haansoft should continue the development of HWP, and introduce a new management. On 20 July, after two weeks of negotiation and assessment of the deal, and under the mounting pressure from the public, Haansoft finally agreed on the terms. It abandoned the original deal and accepted the take-over bid of the 'Alliance for saving HWP' in 35 days from the initial announcement of original agreement with Microsoft.

8.4 Closure: Convergence on Unicode

Through the second phase of Korean national character set controversy, the new international standards regime of ISO/IEC 10646-1 and Unicode had been a subject of keen interests to the actors involved in Korean character encoding. The growing prospect of the new standards was behind the local controversy in 1995

[24]Interview given by Hyun Jin Seo, on 13 August 2000.
[25]Interview given to the ETNews 24 June 1998.

and 1998. Even though the new standards were not taken up by the Korean software industry immediately after the Korean repertoire enlargement and rearrangement in 1995, towards the end of the 1990s, Unicode, in particular, became more widely adopted as the basic character set for operating systems and applications software. It was the convergence on the Unicode standard that finally brought the two decades of Korean character encoding controversy to a closure in 2000. This section summarises, first, the radical change in the Korean character encoding environment made by the increasing adoption of Unicode, second, some of the unsolved problems in Unicode implementation in Korean context, and third, an occasion which marked the closure of the Korean controversy in 2000.

From the late 1970s to the mid-1990s, ISO 2022 had been a major criterion by which the technological properties of the two rival Korean character sets, Johap and Wansung, were judged.[26] Through the latter half of the 1990s, however, the new international standards from JTC1 and Unicode consortium, being largely driven by the globalisation of software market and facilitating it at the same time, have been steadily integrated in the system and applications software by major multinational software houses. The new international standards regime has transformed the ground on which the Korean controversy over national character set standards has been framed. The Unicode standard removed the rigid stricture of the ISO 2022 rules on the Korean character encoding and opened a new horizon. For the first time since the Korean character set standardised on the fixed two byte solutions based on the 16-bit IBM PC architecture, support for the full range of Korean script no longer necessarily conflict with the international standards.

As one of the main contributors for the Unicode consortium and one of the largest producers of software of global reach, Microsoft was quick to exploit the

[26]See the section 6.3 and 6.4, for the contrasting technological properties ascribed by the competing experts groups on Johap and Wansung.

new standard. Microsoft introduced the Unicode-based system software, Windows NT 3.1, for server market back in 1993, and included MSLU (Microsoft Layer for Unicode) - a set of Unicode APIs on which Unicode-based applications could run - in Windows 95 (Kano 1995, Kaplan & Wissink 2001). However, the Unicode support in Korean personal computer market was delayed until 1998, for the Windows NT was targeted for the server market, and the Unicode support in Windows 95 Korean version was suppressed over the controversy on the use of Extended Wansung Code System in 1995. The widespread adoption of Unicode by applications was put on hold due to the absence of system level support. Then, in 1998, one month after the controversy over the fate of HWP, the Microsoft Korea enabled MSLU (Microsoft Layer for Unicode) in Windows 98 Korean version which became the first system software supporting Unicode (thus KSC 5700:1995) in Korean personal computer market.

The growing prospect of Unicode had inspired researches and experiments on the Korean character encoding with the Unicode standard, and this, in turn, raised concerns over various points. Three of them were most commonly identified. First, Unicode inherited the compromise of dual standards by including two different types of Korean character encoding methods, and therefore created a source of confusion and tension (National Computerisation Agency 1997, p.21). In Unicode, a Hangul syllable could be encoded by the 'syllable encoding' method using one of 11,172 code points for Hangul syllables, but also the same Hangul syllable could be encoded by the 'jamo (character) encoding' method using a combination of two to three code points allocated for 240 Jamo.[27] The syllable encoding has its heritage in the Wansung standards, KSC 5601:1987, a simple one to one match between a list of alphabetically ordered precomposed Hangul syllable to a code point. The use of 240 Hangul Jamo was modelled after the character encoding tradition of N-byte code, 3byte code, and Johap, each of

[27] 11,172 Hangul syllables (precomposed combinations of individual jamo) and 240 Hangul Jamo (constituent parts of Hangul syllables) are located in two separate blocks, in AC00-D7A3 and 1100-11FF respectively (Unicode Consortium 2000, pp.275-276).

which had different length and ways of encoding Jamo but shared their focus on the Jamo as a unit (or sub-unit) of encoding. The two competing approaches, Wansung and Johap, had been accommodated together in the dual standards regime of KSC 5601:1992 in the past. By accommodating both methods, initially, it could easily muster approval from both groups supporting different methods, but it also can lead to confusion in sorting and searching text due to the presence of alternatives for the same Hangul syllable.

Second, the mixture of two methods became another source of concern, for the syllable encoding method - the use of 11,172 Hangul syllable - was expected to be better supported in the market but it was also considered not flexible enough to absorb the future changes of Korean repertoire. Considering the practices of software developers in the past, the industry was likely to concentrate on the syllable encoding method, the easier option for implementation. The lack of support for the Jamo encoding method in Unicode, critics argued, would led to the exclusive use of 11,172 Hangul syllables and the eventual loss of Jamo encoding method in the long run (National Computerisation Agency 1997, p.18). This would have negative implications, in particular, for the future repertoire change in Korean script, which became a definite possibility as the scholars on Korean language from South Korea, North Korea, and China began their efforts to harmonise character repertoire after decades of independent development in North and South Korea and Korean minority in China.[28] In the syllable encoding method, change of a few Jamo would trigger a much larger modification of repertoire. The process of precomposition for an extra vowel, for example, requires the addition of 532 new code points and changes of thousands more depending on the location of the vowel in alphabetical order, a major disruption of the character set standards. This would be a particularly awkward problem considering the promise Korean delegate made in the 27th JTC1 SC2/WG2 meeting

[28]From 1994, annual meetings of the International Conference on Computer Processing for Korean Language (ICCKL) have been a focus of international cooperation for international Korean script harmonisation(Kim 1999).

in Geneva that the request of Korean codespace enlargement would be final if the 11,172 contiguous space were granted (JTC1/SC2/WG2 1995). In contrast, there would be no such problem under the Jamo encoding method, for the changes of code points would be exactly the same as the repertoire change in Korean script itself.

Another source of concern over the Unicode standard came from the use of 'Unified Han Ideograph.[29]' The benefit of unified Han ideograph is obvious with thousands of code points saved from the waste of duplication. However, different ways in which the characters have been used in different countries complicated the character encoding with the unified Han. First, even though China, Korea, and Japan share many of the Han Ideographs (Hanja in Korea), the forms, meanings, and pronunciations of the some characters varied across countries, moreover, the criterion for sorting the characters are different; China used the radical and number of strokes, while Korea and Japan used the pronunciation of the character for the purpose. The differences among countries had required many years of researches and negotiations for the unification process,[30] and led to three separate areas for Han ideograph within Unicode; CJK Unified Ideographs, CJK Compatibility Ideographs, and CJK Unified Ideographs Extension A (Meyer 1999). For example, in Korea, the character (樂) has four different pronunciations and appear four times with unique code points in KSC 5601:1987 (Ministry of Culture, 1997, pp.25-27). In order to maintain the compatibility with Unicode and to safeguard against any loss of information through conversion, Unicode has 'CJK Compatibility Ideographs', separate from the CJK Unified Ideographs area (Unicode Consortium, 2000, p.267) . Second, there is another unresolved problem for Unified Han Ideograph use in Korean context. China,

[29] It is also called 'CJK Unified Ideographs,' for the repertoire were selected from Chinese, Japanese, and Korean usages of the ideographs and pooled into one large unified repertoire instead of one for each national language(Unicode Consortium 2000, p.258).

[30] Apart from JTC1 SC2/WG2 meetings, there were 14 dedicated meetings for the Han Unification until 1997, 5 times under the title of Chinese/Japanese/Korean Joint Research Group, and 9 times under the changed settings of Ideographic Rapporteur Group (IRG)(Unicode Consortium 2000, p.961-962).

Japan, and Korean all have their own sets of phonetic characters, Hiragana and Katakana for Japanese, Bopomofo for Chinese, and Hangul for Korean. While the usage of the phonetic characters were different from that of Han Ideographs in China and Japan, the modern Korean writing system allows an arbitrary mixture of both elements in all occasions. Every word that can be written in Han ideograph can be written in Hangul with exactly the same meaning and same pronunciation, causing confusion for sorting and searching document(National Computerisation Agency 1997, pp.19-21).[31]

Meanwhile, the support for the Unicode standard in the Korean personal computer software market was well advanced with the launch of fully Unicode based system software, Microsoft Windows 2000, and the most popular productivity suite, Microsoft Office 2000. The Unicode environment, despite some remaining issues mentioned above, opened a completely new ground in terms of Korean applications software market. There remained no gap between the applications requirements on character set and the Windows system software environment, and there was no contradiction between the local demands for large repertoire and the international standards. The sea change, naturally, posed a serious challenge to the HWP. Since the Microsoft Windows and applications began to support Unicode with full 11,172 Korean Hangul syllables, the HWP lost the most distinctive competitive edge against more functionally sophisticated Office suite of Microsoft. Moreover, for the HWP were based on its own collection of Input/Output libraries customised for the Johap character set, the maintenance of those proprietary libraries under evolving Windows environment became a more arduous and costly task for the developer of HWP, Haansoft.

> When MS-DOS was the main operating system, the extra burden for maintaining Korean Input/Outout system at application level was relatively light, for operating system at the time did not provide many functions. But its costs and workload

[31]Government has pursued a Hangul-only policy for official documents since 1948, but the impact of the policy has varied across different areas of writing, and the legality of policy itself and the appropriate level of Han ideograph in national writing system, in general, have always been a sensitive issue for more than a hundred years (Koh 2000).

> began to increase rapidly when HWP had to adapt itself to the Windows environment. Due to its different character set type and applications level Input/Output processing, HWP could not utilize many of newly provided resources from Windows APIs, and it had to include those functions within itself. This became an increasingly serious obstacle for the development of HWP.[32]

Since Microsoft launched Windows 98 Korean version with Unicode support and pronounced the specifications of the upcoming Microsoft Office 2000 which would be written with the Unicode as its base character set, Haansoft began to show signs of change in company's character set policy. Even though the first new version of HWP marketed after the controversy over Microsoft's investment was true to the company's traditional character encoding approach, the outgoing manager of the Haansoft already hinted at the possible changes in the character encoding,[33]and the new management revealed a blueprint of a 'light and compatible' HWP version 5.0, in a promotional event, stressing that it would utilise standardised Windows libraries so that the new product would be smaller, faster, and more compatible with other competitors.[34] For a while, the Haansoft continued to upgrade and marketed the Johap-based HWP, the introduction of Hangul 97 Upgraded version on 5 May for example. Therefore, the competition between Johap and Wansung seemed to transform into a new competition between Johap and Unicode. However, on 9 October 2000, in two years time from the 1998 controversy involving Microsoft's conditional offer and on the 10th anniversary of its foundation, Haansoft Ltd. launched a new class of word-processor called 'Wordian,' which was built on Unicode-based Windows APIs. With the Johap character set standard and the accumulated Input/Output libraries abandoned, the Haansoft's conversion to Unicode effectively ended the two decade old controversy on the Korean character set standardisation.

[32]Interview with Sang-Hoon Jun, 31 July 2000.
[33]ETNews, 21 July 1998.
[34]ETNews, 9 October 1998.

8.5 Conclusion

The second phase of the Korean character set controversy was characterised by the competition between the two rival character sets against the backdrop of changing international standard regime, the return of the public controversies in 1995 and 1998 which affected the usage of the character standards in Korean market, and the closure of the whole national standards controversies with the convergence on Unicode. First, during the period of 1992 and 1994, the new national standard KSC 5601:1992 had not significant effect on the balance between the Wansung and Johap character set standards, the Wansung standard was entrenched in the market during 1987-1992 with the support of Windows system software. However, the Johap character set remained popular in niche markets, in particular, the word-processor market where the HWP with the Johap character set retained its supremacy against Wansung-based competitors.

Second, the controversies in 1995 and 1998, though different in nature, were both related to the character set standards issue. The controversy over the Microsoft's Extended Wansung character set demonstrated again that even though the public controversy had remained dormant for years, the character set standard was still very sensitive and important issue in Korea, and the standardisation process was shaped by an unpredictable, complex, and intrinsically social process. With new, technically versatile, culturally adequate international and Korean national standards in sight, most of Korean constituencies strongly resisted the Microsoft's deviation from the publicly accountable national standardisation process to a proprietary solution. The controversy in 1998 was not directly connected to the character set standardisation but an incidence of extraordinary reaction organised against the corporate strategy of Microsoft, an attempt to kill off the rival word processor, HWP. However, the series of event had important implications on the standardisation issue. For HWP was the only viable word processor applications based on Johap character set, and its disappearance from market would have meant the loss of accumulated Input/Output libraries and the Johap character set itself.

Third, the second phase of the controversy and the whole Korean character set standardisation process for that matter was finally closed around 2000. Even though the development of the third generation of international standards regime formed one of the most important background of the controversy in 1995 and 1998, until mid-1998, the new standards were not implemented widely in Korean software market, in particular, in Windows Korean version and most of applications designed for the platform. Under the circumstances, Johap and Wansung were still the main contenders for the Korean de facto character set standard, and Johap maintained its popularity over Wansung in word processor market, as HWP provided superior Korean script handling over its Wansung-based competitors. Towards the 2000, however, the situation was reversed when Unicode had been widely implemented by applications and system software, eliminating the advantage of the HWP. The developer of HWP, Haansoft Ltd. was finally persuaded to abandon the Johap character set and its proprietary libraries and to use Unicode and Unicode-based Windows APIs in order to build a smaller, faster, and more compatible product under Windows environment. After two decades of competition, the Korean character set standards eventually converged on Unicode.

CHAPTER 9

Analysis:

Social shaping of coded character set standards

> The new code does come at a cost, in both speed and space. Because each new Unicode character will take twice as many data bits as an ASCII character, a modem will send half as many Unicode characters per second and discs will hold half as much text. The consortium is confident that rapid increases in processor speed and disc capacity will permit Unicode to be introduced painlessly (Beard 1991, p.29).

> Rapid growth of international computer market and changes in world's computing environment is creating a need for a new character code standard. This new standard [Unicode] should enable the computer to adapt to the user's language and cultural environment rather than the other way around (National Computerisation Agency 1993, p.9).

> Leading U.S. software companies collaborated to set up Unicode, a universal and singular character set that can encode all scripts of the world. And the main reason behind the efforts was the localisation of the software. If the system software support Unicode, applications running on the system software can easily support many different scripts and this would save them costs and time to developed localised versions (National Computerisation Agency 1997, p.7).

Even though the standardisation process of Korean national character set has long been a subject of public controversy, some common perceptions held by many participants and observers are fraught with deterministic or simplistic connotations as in the three characteristic remarks quoted above. First, some forms of technological determinism appear strong. For example, it is often assumed that the structural changes in the international character set standards have been dictated by a linear progress in microelectronics. According to the view, as more powerful and more efficient machines replace old ones, the lesser the economic and technological pressure on the resource use for character encoding. As a result, both the second and third generations character set standards could enlarge the codespace of previous standards, and this process ultimately resolved the local problem of a large character repertoire and more global problem of multilingual information processing. Another common perspective on the subject is that the whole course of character set standards setting has been determined through the operation of market forces. From this point of view, the globalisation of economic, political, and cultural activities increased the market demands for multilingual information processing, which, in turn, persuaded standard setters to move from a system of coordinated multiple national standards to a unified system of one multilingual standard, the move from ISO 2022 to ISO/IEC 10646-1 and Unicode. Related to this is the third perspective maintaining that powerful players in ICTs field ultimately shaped the directions of the character set standardisation process to serve their interests. For example, the interests of multinational software houses played a crucial role in its successful construction and increasing adoption of ISO/IEC 10646-1 and Unicode, for the new standards would provide an important strategic resource for a necessary transition from a regime of multiple localisations to that of internationalisation of software core.

The empirical case study into the Korean national character set standardisation, however, provides strong evidence against those deterministic and simplistic accounts of the standardisation process. The study suggests an image of structured, but complex and unpredictable social shaping process in which a variety of economic, social, cultural, political and technological factors have shaped the design and implementation of local and international character set standards through a series of differently configured contexts over time. No single factor dominated the pace and direction of the standards development, no single actor assumes a position of command for an extended period of time under constant shifts of relationship between actors and with technological artefacts. This chapter draws on findings from the research on Korean controversy and aims to construct four main lines of analytical narratives.

The chapter 9 consists of five sections. The first four sections address four main themes developed with the findings of the case study, and they are followed by a concluding section. Section 9.1 examines a popular perspective on the Korean character set standardisation, which can be summed up in a phrase, 'technological fix on a cultural problem.' It shows how social choices were embedded in the technological designs of the generations of international and Korean national character set standards. Section 9.2 looks into the peculiar phenomenon of the Korean public controversy in a field of technological standards, normally an exclusive domain of experts. It tries to answer how the social choices embedded in technological artefacts were obscured by the successful technicisation of essentially sociotechnical process and how the process became repoliticised and even a focus of public controversy. Section 9.3 follows the transformations of interests alliances over the decades of Korean character set standardisation process, and then it focuses on the fluidity of meanings attached to the standards and the unstable nature of relationship between the artefacts and the interests. This draws attention to the immediate and broader factors - from absence and availability of certain technology, to social, political, and cultural settings - shaping the attitudes and perceptions of actors towards the artefacts as well as the interests identified and strategies employed to achieve them. Section 9.4, then, addresses a need for an effective conceptual tool to deal with the complexities involved in this multi-layered and unpredictable process of social shaping. The concept of 'development arena' (Jørgensen & Sørensen 1999) is chosen as the most appropriate conceptual tool employing a broadened and decentralised concept of relevant actors, and maintaining a balance between the activities of actors and the broader contexts around the actions. The arena concept is used to summarise the Korean character set standardisation process as an evolution of 'the Korean character set standardisation arena,' through a series of different configurations of heterogeneous elements. Section 9.5 concludes with the summary of this chapter.

9.1 Technological fix vs. social choice

A received view on the Korean national character set controversy is a story of a 'technological fix on a cultural problem,' in a sense that the technical challenge experienced in the Korean character encoding was a product of distinctive local culture, and the problem was later fixed by steady advances in the information and communication technologies. From this point of view, the first and second generations of international character set standard regimes that were developed in the 1960s and 1970s could not adequately accommodate the need for tens of thousands of code points for Korean script, for the technological capability of the time put strict economic and technological limitation on the size of codespace. However, unrelenting advances in microelectronics and ICTs in general during the 1980s and 1990s gradually relieved the pressure on the codespace, and thus led to the development of the third generations international character set standards and to the later accommodation of the whole Korean Hangul syllable and Jamo repertoire. A comment from a journalist shows the pervasive influence of the perspective:

> As I remember, up to 1995, the whole discussion on the character set standards had been constrained by the technological capabilities of personal computers. Maybe it's not the biggest factor, but certainly, the technological limitation was important part of the discussion. At the time, everyone involved in the controversy had the factor at the back of his/her mind. Even when people began to talk about Unicode, about half the people I know had doubt about its prospect because of the large size of the standard.[1]

[1] Interview with Hyun-Jin Suh, 13 August 2000.

The exclusive focus on the enlargement of codespace through the three international standards regimes seems to have reinforced the perspective, for the number of encodable characters did increase in a rather linear fashion from 94, to 128, and then to 8,836 and 65,536. ASCII and the first generation international character set standards, ISO 646, were based on 7-bit structure and had 94 code points for printable characters. Under the standards regime, the rigid limitation of 94 code points left no option for Korean character encoding but to encode each Jamo and combine two to four of them into a Hangul syllable by dedicated hardware or software, which were not very popular because of the consumption of large memory or complexity involved with the variable length. The second generation international standard, ISO 2022 opened up 128 code points with the 8-bit extension technique, and also allowed far greater code points of 8,836 in the double byte extension scheme. Providing the largest codespace devised so far and the convenience of fixed-length two-byte character set, it became quickly established in Japan (JISC 6226:1978), and China (GB 2312-80), and became a foundation for the first successful Korean national standard, KSC 5601:1987. However, as the 8,836 code points could not cover all 11,172 modern Hangul syllables and thousands of Chinese ideographs used in Korea, it could only provide a partial solution. Then, the third generation international standards emerged in the form of ISO/IEC 10646-1 and Unicode, and radically changed the Korean character encoding environment. It opened up the codespace of 65,536 for printable characters, and all 11,172 modern Hangul syllables were included in 1995 after a series of Korean repertoire expansions within the standards through version updates. Simply put, the historical development of information technology with its linear enlargement of code space from 94, to 128, 8836, and 65536 appears to provide the increasingly powerful technological means to fix the culturally induced technical problem in the Korean character encoding.

However, the investigation into the Korean character set development reveals that social choices were made at various junctures of the standardisation process, and those choices were key factors shaping both the initial challenge to the Korean character encoding and the evolution of Korean character sets standards for two decades. It was found that behind the crucial technological environment constraining the national standard setting - main design features of ISO 2022 and Unicode) - and the rivalry between two Korean character set types - Johap and Wansung - were certain social choices based on the conflicting concerns and priorities of various actors involved in the design and use of the standards.

First, the number of available code points under international standards regimes, ISO 646 and ISO 2022, in no small part, has been shaped by the historical legacy of the previous standards and the dominant social and economic power of the particular regions, U.S. and Western Europe, rather than the lack of resources committed to the character encoding per se. This became clear when the increase in codespace for printable characters is compared with the number of total code points created by physical bit combinations which includes not only the code points used for printable characters but also the code points lost for control functions characters and for the compatibility with the 7-bit environment. As explained in the section 4.1, the total number of potential code points is decided by the number of bit used for encoding each character, therefore, potentially, 7-bit, 8-bit, and double-byte (or 16-bit) code system could have 128, 256, and 65536 code points. However, ASCII and ISO 646 used only 94 code points among the potential 128 for printable characters, for they incorporated 32 control function characters and two other special characters. Then, the legacy of ASCII and the priority given to the 7-bit code over 8-bit code have far greater implications for codespace allocation under ISO 2022. Only 75 per cents of potential codespace could be used for encoding printable characters under the 8-bit extension scheme of ISO 2022, and under the double-byte extension technique, less than 15 per cents of the total 65536 codespace were made usable. As a result, ISO 2022 and ISO/IEC 10646-1 consume the same amount of resource, that is, the whole two-byte stream, in order to process a Hangul syllable, while there is huge difference in terms of number of character repertoire to be encoded, that is, 8836 and 65536, respectively. The disparity in terms of available codespace between the second and third generations of international standards regimes, therefore, lies in the different structural features designed to serve different priorities and objectives, not in the different amount of resource used. The quoted passages from the ISO 2022 and Unicode 3.0 standard documents below clearly demonstrate the different concerns of the designers of each standard. While the primary goal of ISO 2022 is the development of the 8-bit and double-byte code extension techniques that would remain compatible to the existing 7-bit environment, the objective of Unicode is the development of a new multilingual character standard.

> The code elements used in the structure are common to both the 8-bit and 7-bit codes. …… The use of common elements in the 8-bit and 7-bit code structure enables any specific conforming 8-bit code to be transformed into an equivalent 7-bit code, and vice versa, in a simple and direct fashion. …… The use of uniform code structure technique for the 8-bit and 7-bit codes specified here has the advantage of: …… allowing the interchange of data between environments that utilise 8-bit and 7-bit code respectively, and reducing the risk of conflict between systems required to inter-operate (European Computer Manufacturers Association 1994, p.1).

> The primary goal of the development effort for the Unicode Standard was to remedy two serious problems common to most multilingual computer programs. The first problem was the overloading of the font mechanism when encoding characters. …… The second major problem was the use of multiple, inconsistent character codes because of conflicting national and industry character standards (Unicode Consortium 2000, p.3).

Therefore, the limitation of code points and its gradual relief in the successive international character set standards regimes were dependent as much on the way the given resource was managed as on the amount of the resource available.

Second, the formation of two rival Korean character sets, Johap and Wansung, and their dominance in the Korean controversy as a whole, have also been shaped by the assertion of different priorities and interests of various social groups involved in the Korean character set standardisation process, rather than determined by narrowly defined technological considerations. Facing the contradiction between the large repertoire of Korean script and the rigid extension rules of ISO 2022, the designers of Korean character sets had to choose between the comprehensive support for Korean repertoire and the compatibility with the international standard, ISO 2022. True to their design principles, the Johap standard ignores the rules of ISO 2022 in order to include all 11,172 modern Hangul syllables, while the Wansung standard excluded 8,822 of them in order to comply with ISO 2022. It was clear from the early stage of Korean controversy and throughout, the design principles of the two Korean character sets were based on different priorities and concerns of various social groups involved in the standards setting process. Towards the emergence of KSC 5601:1987, for example, the overriding concern for the standard bureau and the advisory committee was to set a national standard which would facilitate a speedy transfer of computer technologies from U.S. and Japan, and to lay the foundations for domestic computer industry for the future national and international market. On the other hand, the priority of the nascent personal computer industry was the consumer demands for full Korean script support and sophisticated text-editing functions, for the success of their products was dependent on the fast growing mass personal computer market (Korean Standards Research Institute 1987).[2]

9.2 Politicisation and Technicisation of Character set standards

Even though the crucial social choices were recognised by actors involved in the standardisation process, there has been a strong and influential tendency towards technicisation in standardisation. The technicised vision of standardisation promotes an image of technical standardisation as a purely technical process in which a superior standard is chosen on the basis of technical merit alone.

[2]See for more, Section 6.2 and 6.3.

In technicised standardisation process, the discussions within technical committees, working groups, advisory committees, and public hearings are likely to be dominated by the logic of technological rationality. Only the technological criteria, it is argued, should be legitimate factors influencing design and implementation decisions of standards. The sentiment were visible among those working in standards development organisations and industry alike:

> Now to the third question - 'What are the major inhibitors that lie ahead and how can the members of this symposium help remove them?' ...... Another inhibitor we have to face is politics. The international standards arena never been dominated by politics and this has been one of its strong features. The facts of life, however, are that political interests and influences are playing an increasing role. The temptation always exists to use standards as a means to achieve political objectives, often by way of procurement power. Generally the use of standards for such purposes tends to be a two-edged sword. Unfortunately, before this is realized the user is again the one who has to pay for the interim folly that has occurred (Rankine 1990, pp.45-47).

> In a particular situation when the pros and cons of alternatives are based purely on technical aspects, the committee is not likely to have difficulty in arriving at a decision. The decision can be made purely on technical merit, and it is simply a question of determining the relative technical merits of the alternatives. The professionals on the committee are very well qualified to make such determinism. Frequently, factors other than technical, such as economic and sometimes social, are involved, and then the committee's decision process becomes much more difficult (C. MacKenzie 1980, pp.4-5).

In an important way, the technicisation of standardisation is an achievement by which technological standards could be set on the basis of consensus among a group of highly qualified experts rather than through a convoluted political negotiation, or wasteful standards wars between proprietary standards in the market.[3] Having been provided with a common language of technological efficiency and feasibility, participants of competing priorities are persuaded to engage in

[3] For the importance of and struggle among standards strategies in information and communications technologies, Grindley (1995) and Shapiro & Varian (1999).

a collective search for a technologically superior standard without resorting to potentially disruptive political manoeuvres in the standardisation process. In a technicised world of standardisation, therefore, the technological knowledge of experts and their description of the technological properties of an artefact tend to become non-negotiable 'hard facts' (MacKenzie 1990, pp.9-10).

However, the successful technicisation of standardisation, on the other hand, presents a danger of reinforcing an asocial image of standard setting process based on objective, disinterested and authoritative technological knowledge. Despite its practical contributions in the standardisation process, this is a problematic perspective, for it inevitably presents a sanitised version of the standardisation process and neglects its political nature. As has been shown through the Korean controversy, the character set standards setting process is largely a political process in the sense that organised interests of diverse actors around the standards compete or mediate with each other. For example, the structure of national representation in the formal standardisation organisations, such as ISO, IEC, JTC1, and ITU, itself implies the existence of conflicting national interests, and the procedures of formal standardisation organisations are designed to ensure the democratic accountability during the negotiation process towards a consensus. The political nature of standardisation is also evident in the rapid growth of standards consortia whose exclusive and qualified membership not only helps a faster production of standards but also facilitates a more direct incorporation of participants' interests in the standards produced (Williams 1999).

In the context of Korean national character set standardisation, the political mode of standardisation was dominant at the early stage. In the 1970s and early 1980s, the standardisation of the Korean character set had been dominated by the market competition among corporate proprietary standards. Computer manufacturers and software developers in Korea opted for competitive standards strategies under which many proprietary character sets were developed in order to lock in existing and future customers. Government, on the other hand, had been pursuing a standards policy of setting up a system of nation-wide official 'de jure' standards, trying to introduce the concept of national character set standard twice in 1974 and 1982.[4] However, the basic idea behind the government standardisation activities was to streamline and reduce the chaotic competition among Korean character sets into a manageable oligopoly of dominant proprietary standards by granting those market leaders the national standard status. Therefore, the aim was to mediate the interests of major players in the field rather than to open a technicised standardisation process for Korean character set. Both attempts in 1974 and 1982 have failed to persuade the industry without clear incentives for the standardisation. In general, the standardisation was left to the competitive standards strategies of hardware and software providers, and there was no concerted effort to transform the mode of standardisation up until the mid 1980s.[5]

Later in 1987, however, the Korean government succeeded in transforming the Korean character set standardisation process from a politicised mode to a technicised one: a shift from a naked pursuit of corporate interests to a broad-based consensus-building process[6] based on the technological debates. From 1985 to 1987, during which the first successful national standard, KSC 5601:1987, had emerged, a technicised mode of standardisation was achieved through the activities of the government standards bureau and the advisory committee. In particular, the advisory committee presented and defended its choice, the proposal based on Wansung rather than Johap (KSC 5601:1987), as a technologically superior solution compared to more culturally adequate Johap proposal.

[4]KSC 5601:1974 Korean Industrial Standard Code for Information Exchange (Hangul and Hanja) and KSC 5601:1982 Korean Industrial Standard Code for Information Exchange (Hangul).

[5]See for more, Section 6.1.

[6]As described in the chapter 6, 7, and 8, the scope of participation for KSC 5601:1987 was much more limited than those of later ones, but the standard bureau followed a consultation procedure both for the industry and the public.

Even though the debates in the advisory committee, forums, and public hearings revealed a hint of conflicting professional interests behind the technological arguments, the government experts successfully monopolised the technological authority on which any judgement of technological properties of competing standard proposals was based. Controlling access to the advisory committee, the government experts in favour of international compatibility dominated the committee. The participation of Johap supporters, though they were the majority in industry, was limited to a series of industry surveys or public hearings. The status and relevance of the ISO 2022 rules were emphasised, and the compliance to the international standard was seen as non-negotiable. Johap supporters' attempt to loosen the extent of compliance - the modification of Johap codespace to make it less disruptive - was rejected as technologically unfeasible.[7] Also, the problem of limited Hangul syllables support - a major argument against the Wansung - was dismissed as insignificant in terms of the overall system performance. The standards bureau argued that the new standard would have the coverage of 97 to 99.9999 per cents of 'normal' usage of Hangul syllables (Lee 1990*b*, Park 1990). As a whole, government maintained the control over the technicised standardisation process with effective use of the advisory committee, and successfully set up a national standard suitable for the impending National Computer Network Project. Despite the broad support for Johap among industry and personal computer users, the criticism against the Wansung could not penetrate the defence of standards authority until the credibility of advisory committee and the standards bureau itself began to be challenged later.

However, the situation changed during the implementation stage of the new standard, as experts in the industry and academia began to voice their discontent through on-line communities and mass media from 1989. Equipped with

[7] A modification of Johap codespace could be made so that it would avoid the area reserved for control functions, however, it would conflict with some meta characters, such as, *, $, ^, ? (Ministry of Culture 1992, pp.33-35).

the expertise in the field of linguistics and information technology, they challenged the advisory committee's justifications of the design decision. First, the critics argued that the missing 8,822 Hangul syllables, even though they appear rarely in everyday usage, were indispensable for the uninhibited expression of the national language, the protection and further development of the cultural heritage, and for language education. Second, critics questioned the emphasis given to the international standards rules, arguing that the international information exchange was irrelevant to most of average personal computer users. Moreover, the new national standard, KSC 5601:1987, was argued to be an inefficient and technologically inferior design given the growing importance of natural language processing, for the Wansung character set did not contain the information for constituent parts of the Hangul syllable it represents, while the Johap character set retained the information due to its structure of 5-bit representation of each of three constituent parts of Hangul syllable.[8] Therefore, the critics challenged the standards authority with the hard, technical arguments as well as the soft, social implications of the national standard (Ahn 1989a;1989b, Kim 1989, Park 1989). As the credibility of official version of technological knowledge was publicly questioned by a group of experts for the first time, the disputes over the national standard began to gain publicity so far denied, and to undermine the image of the new national standard, KSC 5601:1987 as the best solution based on purely technical grounds.

Soon the technological dispute among experts was escalated into a full-scale public controversy, which brought the public's attention to the centrality of social choices embodied in the contents of technological artefacts. Intensification of the debate soon changed the mode of standardisation back to the politicised one. A Key to the process was the experts' disagreement on the technological properties of given standards. In a conference held by an on-line community over the issue

[8]Supporters of Wansung argued that a simple conversion table could perform the task of analysing the composition of Hangul syllables, but Johap supporters claimed that this is a haphazard and inefficient approach, for grammatical analysis of Korean text is essential part of natural language processing and this requires the information of constituent parts of Hangul syllable.

of KSC 5601 amendment plan,[9] for example, the experts from both sides, pro-Wansung and pro-Johap, took the central stage and argued against each other over the technological properties of the standards. This visible split of opinion among experts contributed to undermining the image of neutral and authoritative technological knowledge free from any value judgement, and this, in large part, helped to bring the issue of interests to the fore. Facing the stalemate in the process of technological arguments and counter arguments, participants and observers seemed to be well aware of the broader social, cultural, and political dimensions of the controversy.

> That's (disagreement on technological fact) because there were different views on what is more important when choosing a standard. The choice between character sets is based on a kind of cost/benefit analysis. But, at the same time, the estimation itself is dependent on how important certain benefits are. If you have a very important requirement, this can override all other considerations. This kind of problem usually occurs when there is a clash between the users and developers, or between practical and normative approach.[10]

In most cases, participants made clear their criteria for a desirable national standard, and they determined the technological properties of competing proposals against those criteria. For example, those who supported Wansung emphasised the importance of the international standards regime, compatibility with foreign software and hardware, and efficiency of international communications, when they argued that the Wansung character set could provide a stable and powerful standard (Cho 1990). At the same time, those who preferred Johap highlighted the long-term cultural implications, when they opposed the Wansung as a restrictive and inferior standard (Kang 1990*a*). Therefore, it seems that a version of 'technological property' of an artefact was shared within a group where the members researched a consensus on the primary requirement of the

[9]21 April 1990, 'Conference on Korean character set and keyboard layout', hosted by the on-line community, the 21st Century Village.

[10]Interview with Jun-Hee Lee, 16 August 2000.

character set standard. Identifying factors determining an actor or a group's primary concerns over the character set standard is a complex and empirical question, but what appeared clearly from the early Korean controversy is a strong relationship between the professional interests on one hand, and primary requirements and the technological properties attributed to a standard on the other. For example, librarians, publishers and linguists were primarily interested in the unlimited use of Hangul syllables. Academics in language department was one of the first who openly criticised the national standard based on Wansung (Kim 1989), and publishers and librarians were also active members of the 'Association for Korean Character Set Standardisation,' one of the two leading campaign groups which successfully mobilised funds, expertise, and public support behind the Johap character set.[11] On the other hand, the managers of large computer systems and communications networks - as they were more reliant on the imported software and smooth international data exchange for day-to-day functioning of the system - had priority in the compliance to international standards rules (Cho 1990, Ryu 1990). Different priorities and interests were important factors defining what constituted a technologically efficient and feasible character set standard.

As the interests embedded in the standards were more widely identified, the standardisation process of Korean national character set began to involves active alignment of individuals and organisations with similar interests and concerns. The two overriding concerns regarding the national character set design were the free expression of the national language in computing environment on the one hand, and the international compatibility of the Korean Input/Output system on the other. Along this fault line, two opposing alliances were formed in order to steer the design of national character set standard in their favour. Core supporters for each competing character set, Johap and Wansung, tried to enrol as many social groups and influential individuals as possible by translating various

[11] See for more, Section 6.3 and 6.4.

cultural, economic, and political interests of other actors into those of each opposing camps. The design of character set standards became a subject of political mobilisation of interested parties with the diminishing possibility of resolution by 'objective' technological rationality.

Alignment of interests behind the pro-Johap camp was particularly successful. Diverse interests were aligned within the camp; As the prospect of electronic publishing was growing fast, publishers showed a keen interest in the character set standard with full range of Hangul syllable support;[12] Librarians were adamant that national standard should provide full repertoire of Hangul syllables for efficient maintenance of electronic databases; Linguists and engineers in emerging industry of natural language processing were also supportive of Johap; Teachers and educationists wanted to use computers in education, and supported Johap, for the Johap character set enabled them to use not only all 11,172 Hangul syllable but also the grammatically wrong ones which were entirely missed out in Wansung standard;[13] Software developers, particularly ones with higher application requirements in terms of Korean Input/Output, played an important role by incorporating Johap in their applications and developing necessary sub-routines based on the character set; With significant publicity gain, the Hangul institute and the Hangul foundation, the two most well-known Korean language institutes joined the pro-Johap camp arguing that the Johap character set was an important tool for the preservation and development of the most important cultural heritage, the Hangul script; The majority of personal computer users who already invested in Johap in terms of applications purchased, accumulated databases, and skills obtained with the applications, also became enrolled in the pro-Johap camp; Activists in pro-democracy movements who

[12]'Computer Aided Publishing Society (CAPSO) was core founder of the civic campaign group 'Association for Korean Character Set Standardisation' (Association for Korean Character Set Standardisation 1991).

[13]Apart from 11172 modern Hangul syllables, among which only 2350 were included in Wansung, there are 1148 additional uncompleted, thus grammatically wrong, Hangul syllables.

were discontent with the technocratic decision-making process of national standards and the public with growing interest in the democratic accountability of government policy were also enrolled in the Johap camp.[14]

Confronting those groups of Johap supporting network was the pro-Wansung alliance. The pro-Wansung camp was dominated by the presence of government institutions from the start. KSRI, KRISS, Standard bureau and advisory committee were the initiators of national standards in the past, and all of them were royal supporters of Wansung national standards from its proposal stage.[15] For the early users of imported computer systems and managers of government computer networks, the internationally compatible national standard was one of the most important requirements of national standard. Particularly, the standards bureau had an interest in keeping the national standard within the international regime in order to work effectively as a national member body of ISO. Government executive branches were quickly enrolled in the pro-Wansung camp. Ministry of Industry and Commerce, Ministry of Science and Technology, Ministry of Post and Telecommunication, and later Ministry of Information and Communication were the four most influential government departments, vying for the leading role in the computerisation of the public sector (Seo 1997, pp.182-194), and they were all in line with the government standards authority.[16] The lack of broad-based support outside the government sphere of influence was, however, compensated by their exclusive access to advisory committee in the early stage of national standardisation and the controversial procurement specifications for the early large scale government computerisation projects, such as, the Administrative Computer Network Project and Educational Computer Project.

[14] The foundation of 'Alliance for Promoting Johap Standard' was heavily relied on the activities of 'Korea Young Men's Association of Science and Technology', which, in turn, had strong historical tie with the pro-democracy movement based on Universities in the 1980s (Alliance for Promoting Johap Standard 1991a; 1991b).

[15] Korean JTC1 SC2/WG2 was not included here, for it was mainly in charge of the Korean participation in the third generation of international standards, and it also included all the major players from both sides.

[16] Ministry of Culture changed its position in 1992 in favour of Johap, when it heavily involved in its own computerisation project.

9.3 Shifting alliances of Interests

The distinctive alignment of interests explained above had first emerged during the period of 1986-1990 against the backdrop of the national standards setting processes of KSC 5601:1987 and KSC 5657:1991. Given the contrasting interests of parties involved and the intensity of the debates, the coalition appeared to have achieved a high degree of stability, which seems to fit rather well to a static model of interest explanation of standardisation.[17] However, another important finding from the case study is a dynamic nature of interests alliances and unstable relationship between the artefacts and interests. The alliances of interests had transformed repeatedly through the two decades of Korean national standardisation controversy, forming five instances of distinctive interests alignments. As a result of network building activities of actors and the changes of circumstances surrounding the standardisation process, actors' judgement on the technological properties of character sets and their interests in them have altered. Accordingly, the coalitions of the interests have been shifting, suggesting that the relationship between the artefacts and interest is not intrinsic or permanent but fluid and unstable. Shifting interests alignment at various junctures has had various impacts on the standardisation process. Sometimes it tipped the balance of power between the two interests alliances, thus leading to the introduction of changes in national standards. There also were occasions when a change in the interests alignment altered the nature of controversy itself, leading to, for example, temporary suspension or complete dissolution of the controversy. The rest of this section summarises the five occasions of interests alliances and the changes in the character set standards.

The first alignment

The first round of interests alignment had been formed around 1987, and it was consolidated during the period of 1989-1991 with the controversial government

[17] Schmidt & Werle's (1992) 'actor-centred institutionalism' is an example of this otherwise insightful approach.

plan for amending KSC 5601:1987. The pro-Johap coalition had broadened its basis and gradually increased pressure on the government standards bureau and advisory committee. In 1990, the efforts bore fruit, forcing the government to acknowledge the limitations of the existing standard, KSC 5601:1987, and the need for amendment. The direction of the government amendment plan, however, was to supplement the existing standard with supplementary sets of additional Hangul syllables and Chinese characters without changing the much-criticised structure of KSC 5601:1987. From the viewpoint of the pro-Wansung camp, the international compatibility was paramount, and the amendment should be an extension of existing standards under international standards rather than an overhaul of the system and replacement with Johap as suggested by Johap supporters. For the standards authority, the amendment plan (KSC 5657:1991) seemed to be a satisfactory solution for both national and international challenges it faced. First, domestically, this would soften the strongest criticism against the existing national standard, that is, the serious shortage of Hangul syllables. Second, it would also strengthen the government position in the international standardisation organisation and its claim for more code points for Hangul syllables in the newly developing international character set standard, UCS (Universal Character Set). At the time of the controversy, the structure of the UCS (DIS 10646) remained compatible with the ISO 2022 rules, and any claim for extra codespace should be made with national standards status.[18]

> Korea Standards Research Institute (KSRI) conducted a research to solve the problem of limited Korean repertoire of existing national standard (KSC 5601:1987), and produced two supplementary sets. ...... For the new international standard (UCS) is most likely to be adopted widely, we must make sure that our requirements be reflected in the UCS. In order to do that, Industrial Advancement Administration (IAA) requested the inclusion of both supplementary sets in the 20th

[18]Standard Bureau was under pressure from JTC1, for Korean delegates failed to deliver the new Korean extended character set to JTC1 SC2/WG2 until the 21st meeting in October 1991, which was originally requested in the 18th meeting in September 1990.

> JTC1/SC2/WG2 meeting. In the 21st meeting, only the first supplementary set[19] was accepted in UCS on condition that this should be included in Korean national standard itself.[20]

Although the pro-Johap camp was rapidly organising itself, it remained marginalized in the government-led standardisation process, and the government successfully approved the KSC 5657:1991 as a supplementary set of the existing standard, KSC 5601:1987.

The second alignment

Soon, however, the balance of power was shifting and the new alignment of interests was emerging. The situation of late 1991 and early 1992 was characterised by the successful network building of pro-Johap coalition led by the two civic campaign groups and the crucial defection of the Ministry of Culture from pro-Wansung to pro-Johap coalition, breaking the unanimous government support for the Wansung national standard. First, the period of 1991-1992 marked a fundamental change in the power balance between the government and civil society concerning the character set standardisation process. The shift occurred within the context of the political and social democratisation of South Korea. The pro-democracy movement intensified from the early 1980s and it finally led to a constitutional change in 1987 and broader political and social democratisation of Korean society, which witnessed a massive growth of social movements in the early 1990s (Lee 1993). The historical event set an important background for the emergence and success of the two campaign groups, 'Alliance for Promoting Johap Standards', and 'Association for Korean Character set Standardisation', which effectively mobilised massive support for the Johap character set standard by enrolling actors, ranging from experts in government and industry to opinion leaders in politics, academia, and general public. The success of the former group was indebted to the activities of the 'KYMAST (Korea Young Men's Association

[19]The final supplementary set for KSC 5657:1991 includes 1,930 modern Hangul syllables, 2,865 Chinese characters, 1,754 old Korean Jamo and syllables, and 1,410 other symbols.

[20]Joong-Seong Cho, in a report to Korean JTC1/SC2 of attending the 21st JTC1/SC2/WG2 meeting.

of Science and Technology)' which had a close relation with the organised student pro-democracy movement in the 1980s,[21] and the latter group is one of the new brand of issue-based social movements emerging in the early 1990s. The activities of the two campaign groups elevated the status of character set standards issue from an obscure technological debate among experts into a prominent public agenda, beginning to put immense pressure on the government to rectify the situation.

The organised campaigns, however, had not been materialised until the solid line of pro-Wansung alliance was weakened from inside. There had been hints of strife among government branches and agencies for some time. For example, three government departments, the Ministry of Industry and Commerce, the Ministry of Science and Technology, the Ministry of Post (later the Ministry of Information and Communication) had been competing for the leadership position in the public sector informatisation(Seo 1997, pp.182-194). In regard to the character set standardisation, however, they had all supported the national character set standards, KSC 5601:1987 and KSC 5657:1991, helping the standards bureau to maintain its course of standardisation policy based on Wansung and ISO 2022. However, the Ministry of Culture had faced difficult challenges in its own computerisation projects due to the limitation of the national standards.

> One such occasion (problems with national standard) happened when we were assisting Korean Language Society's project of Korean dictionary for place name. We had come across with many words beyond the repertoire of KSC 5601:1987, which, the standard authority argued, was extremely unlikely to happen. Some of these words could not be found even in the KSC 5657:1991, a supplementary set devised to cover the words beyond the remit of 5601:1987. It was very disturbing because that's about the time when Korean language society published its Korean dictionary, and we started our own project of Korean dictionary.[22]

[21] Founded in 1991, KYMAST aimed to facilitate democratic social reforms by engaging in research and activism on various scientific and technological issues (APJS Bulletin, Vol.1 p.41). A former activist of KYMAST links the outlook of the association with the nationalistic and pro-democracy lines of the student movement in the 1980s (Interview with Jun-Hee Lee, 16 August 2000).

[22] Interview with Won-Sun Lim, 22 July 2000.

Realising its interests undermined by the existing Wansung-based national standards, Ministry of Culture decided to join the pro-Johap campaign. The defection was a significant boost for the pro-Johap camp. As a government branch responsible for national language policy, the decision of Ministry of Culture has an enormous symbolic and propaganda value for the public, and it also considerably weaken government position by dividing government opinion inside and persuading other government institutions to approach the standard issue with their own agenda.[23] The synergy between the activities of civic groups and the Ministry of Culture's conversion was the most important contributory factor behind the introduction of the new national standard, KSC 5601:1992.

The third alignment The two main features of the third interests alignment were the unprecedented cooperation among the former adversaries within the newly founded experts committee, Korean JTC1/SC2, and the concerted actions of the committee and industry together in their efforts to improve Korean script support in the new international standard setting process of UCS and Unicode. First, the foundation of Korean JTC1/SC2 and WG2 was a turning point in the Korean character set standardisation. For the first time, the committee embraced most of active experts engaged in the controversy under one formally instituted government body for the standards policy decision-making. While the relationship between the pro-Wansung and pro-Johap alliances remained confrontational until early 1992, the standard bureau called for urgent attention to the development of new international standards, UCS and Unicode, and pleaded for cooperation of industry experts and academics in order to appropriate as many code points as possible for Korean script within the new standards. In an effort to achieve this, the government passed in 1991 a piece of legislation to set up an expert technical committees entrusted with a task of advising the Industrial Advancement Administration, Korean national member body of ISO and IEC, on the matter of

[23] In the public hearing on June 1992, the disarray in the Wansung camp was clearly visible. Ministry of Education, Ministry of Trade and Industry, and even Standard bureau softened their positions on the issue (Alliance for Promoting Johap Standard 1992).

standardisation (Industrial Advancement Administration 1991*a*). Based on the legislation, Korean JTC1/SC2 (Sub Committee 2) and JTC1/SC2/WG2 (Working Group 2) were created with a broad membership of experts from government executive branches, research institutes, industry and academia in relevant fields.[24] The new institute played a major role in Korean participation in the UCS project from 1991 onwards, voting against the DIS 10646 and drafting Korean proposal on the DIS-2 10646. For the first time, the experts from industry and academia assumed a major role for shaping the government standard policies on character set.

The Korean participation in the UCS and Unicode benefited greatly from the contributions of newly included experts from industry and academia, and the Korean standardisation activity in general gained enormously from the improved communication and co-operation made possible by the committee. As was shown in the chapter 7, the new committee played the major role in the successful enlargement of the Korean repertoire within the UCS (ISO/IEC 10646-1:1993). Moreover, with the momentum built from the experience of domestic co-operation and active involvement in the international standard regime, the government, academia, and industry including the two archrivals in the Korean word-processor market, Microsoft and Haansoft, effectively collaborated in order to obtain maximum code points for Korean script in UCS and Unicode in 1995.

> When ISO/IEC JTC1 meeting was held in Seoul in 1992, our aim was to include all modern Hangul syllables of 11,172, or 240 Jamo instead of the Hangul syllables. However, the original purpose of conference was the ratification of the ballot already cast. It was not a suitable occasion for a radical change we were proposing. We had informal meetings with U.S. delegates in order to contain the expected opposition from Japan and China. But, the original proposal was objected by U.S. (with some mutual misunderstandings), then Japan, and China (as expected). In 1995, the situation was changed in Unicode Technical Committee. New delegates

[24] For example, the committee convened on Mar 1992 consists of 30 members; 12 from government institutes, 15 from academia, and 8 from industry (Korean JTC1 1992*b*).

> from Microsoft had their objection scrapped after the cooperation with Microsoft Korea, and supported the Korean proposal to include all 11,172 modern Hangul syllables and to reshuffle the code points of already included Hangul syllables with additional ones. The change was accepted in the ballot by the margin of just one vote.[25]

> There was a concerted effort between Microsoft Korea, Haansoft, and Ministry of Culture to incorporate all 11,172 modern Hangul syllables in Unicode. The role of Microsoft Korea was essential to persuade Microsoft in favour of our position of including all Hangul syllables. Even though Microsoft Korea was under severe attack for its controversial launch of proprietary Korean character set, 'Extended Wansung' for Windows 95 Korean version, it was a necessary step for us and turned out to be very helpful for this change. The main reason for criticism was that the proprietary standard did not support Johap but added the rest of modern Hangul syllables excluded in KSC 5601:1987 in a separate block for the backward compatibility with previous system. However, if it had not included all modern 11,172 Hangul in, what we called, Korean 'code page', it would have been impossible to persuade Microsoft Unicode delegates to support the Korean proposition, for the organisational policy of Microsoft US was to acknowledge the characters included in the code page scheme they had developed. Microsoft Korea's decision on the 'Extended Wansung' in 1995 came from the forecasting of trend - prominent role of Unicode. And this was shared by other firms in Korea like Haansoft which bought its membership in Unicode and took part in a contested voting for the inclusion of all of 11,172 modern Hangul syllables.[26]

The collective efforts finally paid off with the inclusion of all 11,172 Hangul syllables and an additional 240 Jamo within the UCS and Unicode in 1995,[27] thus, radically transforming, though not immediately in the market, the environment in which the controversy on the Korean character set had been founded. The new international standard, ISO/IEC 10646-1:1995 was adopted as Korean national standard KSC 5700 in 1995.

[25] Interview with Tae-Jin Kang, 17 August 2000.

[26] Interview with Sang-Kyu Ahn, 8 August 2000.

[27] ISO/IEC 10646-1:1995 and Unicode 2.0 are the first versions equipped with the full repertoire of 11,172 modern Hangul syllables. Chinese characters used in Korea are included in the Han Ideograph area. See Figure 7.2 for gradual enlargement of the Korean repertoire in UCS and Unicode projects.

The fourth alignment The fourth alignment of interests was characterised by the return of the public controversy over the character set standardisation. The foci of new controversies were two instances of Microsoft Korea's strategic manoeuvres and the reactions from other domestic constituencies in 1995 and 1998 respectively, the first of which directly affected the character set standards issue, and the latter did not involve the standards issue but had important bearing on the matter as a consequence. When Microsoft Korea were developing Windows 95 Korean version, the company had to consider the global market trend on one hand - internationalisation of software and the new international standards regime[28] - and the local context of national character set standards development on the other. Microsoft Korea opted for a two-step conversion strategy towards the new Unicode system by using an 'interim solution,' in order to link existing nationals standard, KSC 5601:1987 and the future solution, Unicode.

> Large company like Microsoft has to consider the need for development stages, (because of large installed base and backward compatibility), and we often are forced to go with 'interim solution.' In principle, there is consensus that we should support all Hangul syllable. ⋯⋯ But the company had already began Unicode support, and we all thought that's the way to go. So, given the time we had for the Windows 95 Korean version, we could not change all display engine and font scheme for Johap, but had to go with 'Extended Wansung.' [29]

However, when the Microsoft Korea announced the plan for 'Extended Wansung,' in Windows 95 Korean version, the rest of the major domestic constituencies - government, industry experts, the users' community - were against the decision. The Johap supporters was disappointed, for they expected Microsoft would integrate Johap, a part of new national standard since the KSC5601:1992, into the Microsoft's new system software.[30] Except for a few who cautiously welcomed the extension of available Hangul syllable,[31] other experts in industry

[28] Kano (1995) shows the internationalisation solutions used by Microsoft in Windows 95 and NT.
[29] Interview with Sang-Kyu Ahn, 8 August 2000.
[30] Microsoft Korea itself promised to support the Johap in forthcoming Window 95 Korean version in a press conference given by Microsoft Korean on 18 May 1995.
[31] ETNews 20 May 1995.

and academia strongly criticised the messy structure of 'Extended Wansung' as complicated and inefficient design, standing squarely against the principle of the Hangul writing system. The Microsoft's move was also perceived as a threat to and an attempt to bypass the consensus-based national standardisation process which had been achieved by collective efforts and running successfully for years.

> Five hundreds year old principles and practices of Hangul writing system are being undermined by the corporate profit motive of Microsoft. [32]

> National character set standards should be designed for its long-term prospect of at least 30 years, but it is currently controlled for the short-term convenience of corporations.[33]

> Apart from the structure of standard, another source of problem was the process by which the standard was produced and implemented. Both the Wansung and Johap standards were formulated by government institutions through due process including consultation of experts and the public. But the Extended Wansung was unilaterally given to us. The national character set standardisation should not be an object manipulated by multinationals (Park 1995, p.231).

The opposition quickly formed an alliance and requested Microsoft Korea to attune its character set policy to the Korean national standards or the international standards under development, that is, either to stay with the Wansung standard (KSC 5601:1987) or the use Unicode with contiguous 11,172 Hangul syllables. Under increasing pressure, but after several changes of its positions, Microsoft Korea chose a compromise and launched the Windows 95 Korean version with the half-functioning new proprietary character set, which was, in effect, the same as the current Wansung standards.

In three years, a new controversy occurred over the destiny of HWP, the most popular word processor in Korean market. The Asian economic crisis of 1997-1998 formed an important background to the incidence. During the turmoil of currency depreciation and a chain of bankruptcies, and the following period of

[32] Jung-Young Byun, Interview given to ETNews, 10 June 1995.
[33] Kyung-Sok Kim, Interview given to ETNews, 10 June 1995.

restructuring, many Korean companies were in search for partnership with or were acquired by foreign capital.[34] On June 1998, Microsoft Korea made a conditional investment offer to Haansoft Ltd., the developer of HWP which was the most popular word-processor and the sole champion of the Johap character set in Korean software market. The condition for Haansoft Ltd. was to discontinue HWP development and withdraw from the word processor market. Considering the market share of HWP and the financial difficulties faced by Haansoft, the situation of mid-1998 presented Microsoft Korea a good chance to consolidate the market share of Microsoft Word in the Korean word-processor market.

However, the offer triggered an unprecedented public outcry and led to the most intense controversy and the most successful public mobilisation campaigns through the whole Korean character set standardisation process both in terms of the public awareness and extent of the resource mobilised. Before long, a grand alliance was created in order to keep the popular application from being terminated in the way many observers believed illegitimate. While there had been several competing strategies to safeguard HWP,[35] and the government was ambivalent on the issue,[36] the most influential campaign group, 'Alliance for saving HWP' obtained most supports from the other activists and the public with a financial package to take over Haansoft and continue to develop HWP. In a month, the campaign succeeded in overturning the initial agreement between Haansoft and Microsoft and taking control of the Haansoft with new management.

[34]See for more, Demetriades & Fattouh (1999) and Radelet, Sachs, Cooper & Bosworth (1998).

[35]Apart from a minority in favour of uninhibited market competition, there were at least three different centres of mobilisation against the deal: First, the majority preferred an alternative investment offer by a new consortium who would see the continuation of the HWP. Second, another campaign group sought to develop an open source HWP project with the transfer of ownership of the application to the public. Third, the other group supported the alternative investment, but organised a contingency plan to develop a substitute application in case that Microsoft bid should go ahead.

[36]Fair Trade Commission seemed to be alert to the possible breach of the Fair Trade Law, but did not act until the deal was cancelled. And while Ministry of Information and Communications was in favour of the foreign direct investment, Ministry of Culture was strongly against the deal (ETNews 24 June 1998).

Most commentators concurred that Microsoft's attempt on HWP was an example of its aggressive marketing strategies to dominate Korean word-processor market[37] and it was not connected to the character set issues directly. However, it seemed likely that the deal between Microsoft and Haansoft, if succeeded, must have had major implications for the Korean character set standard. As the unique capabilities of HWP was based on the use of proprietary Input/Output libraries based on the Johap character set and HWP was the only viable applications software based on Johap, the fortune of Johap was tied to that of HWP. The disappearance of HWP would have hastened the demise of the Johap character set in the Korean character encoding. Therefore, the two broad alliances against Microsoft Korea, therefore, in effect, delayed both the marginalisation of Johap and the early adoption of Unicode both in 1995 and 1998.

The fifth alignment

The last phase of the shifting interests alignment was the virtual convergence of the market on Unicode and the consequent dissolution of alliance behind the Johap character set. Even after ISO/IEC 10646-1 and Unicode included the full repertoire of 11,172 modern Hangul syllables in 1995, the potential of these standards had not been adequately exploited for years mainly because of the absence of system-level support for the new generation of character set standards. The situation has changed with the advent of Unicode supporting system software and applications, such as, Windows NT, Windows 98, and later on, Windows 2000 and Microsoft Office Suite 2000. The success of those products in the personal computer market radically changed the strategic position of the Johap-based HWP compared to the other mainstream word-processors. As Unicode (also Korean national standard, KSC 5700) became the basic character set of Microsoft Windows, the most popular system software, applications based on Windows APIs could automatically support the whole range of Hangul syllables and

[37] Microsoft Korean was later sued to Fair Trade Commission over its controversial CA(Campus Agreement) and SA(School Agreement) systems by which educational institutions purchase the office package with substantial discount (ETNews, 21 May 1999).

Jamo. This enables Microsoft and other third party developers to produce applications which have as large a Hangul syllable repertoire as HWP but without extra burden of proprietary Input/Output routines. The main attraction of the HWP was the its full coverage of 11,172 modern Hangul syllables using the Johap character set, but this advantages was achieved at the cost of custom-written, Johap-based, additional proprietary Input/Output routines.

> Under MS-DOS environment, system software was not providing a lot of support for applications. So there was not much difference between writing applications with system-level input/output routines support and writing applications and those routines for yourself. But the extra work load got bigger, as the Windows environment came along. We couldn't use countless system-level functions for applications, but we had to write everything just because we used different character sets. This has been a major obstacle for HWP.[38]

When the comparative advantage was lost with the Unicode support in system software, the judgement over the technological properties of the HWP and its Johap-based Input/Output routines changed from the 'powerful' and 'efficient'[39] to the 'cumbersome' and 'costly'.[40] As the meanings attached to the artefact radically changed, the interests alliance anchored on the Johap character sets began to disintegrate. In 2000, Haansoft decided to abandon Johap and opt for Unicode-based Windows APIs for the development of a new series of word-processor applications, 'Wordian.' The enlargement of Korean repertoire in Unicode and the deployment of Unicode in Windows system software have changed the main technological properties and meaning people had attached to the HWP and the Johap character set for two decades. This, in turn, contributed to the dissolution of the interests alliance anchored to those meanings.

[38] Interview with Nae-Kwon Jung, 17 August 2000.

[39] From early on, these were seen as two main characteristics of HWP, for HWP supported for all 11,172 modern Hangul syllables and the its Johap character sets were better poised for Natural Language Processing (Kim 1989).

[40] Apart from the comments from programmer of HWP itself quoted above, the management of the Haansoft itself emphasise the small size and faster speed of the new line of its word processor due to the use of Windows APIs (ETNews 9 October 1998).

The transformation of the interests alliance, therefore, has been based on the actors' reflexive assessment of the changing environment affecting the perceived technological properties of given character set standards and the prospective interests served by those standards. To recap some of major changes, the defection of the Ministry of Culture was strongly influenced by its desire to develop its informatisation projects when the existing national standard became an obstacle with limited repertoire of Hangul syllables. Both the government's shift from the exclusive to inclusive standards policy and the unprecedented co-operation among former adversaries were driven by the changing prospect of the new international standards and the chance they opened for the local actors to shape the direction of the new international standards according to the their needs. Microsoft's deviance in 1995 from the existing national standard reflected the transition of the international standard regime from ISO 2022 to Unicode and the shift of meaning given to the national standard, KSC 5601:1987, from a convenient tool for entering a local market to a cumbersome burden on the new strategy of software internationalisation. Finally, Haansoft's decision to abandon Johap in 2000 ultimately showed that the relationship between an actor and an artefact was contingent and circumstantial. Unicode's growing dominance in the system software market and the complexity of Windows APIs finally transformed the meaning attached to Johap from a uniquely powerful Korean character set standard to an inconvenient and costly one.

9.4 Networks of Actors in a Transforming Terrain

As was shown in the case description and the discussion above, one of the most significant features emerging from the Korean character set standardisation controversy is its complexity. At a superficial level, the controversy appears to have been a local and technical issue, which was confined to a locale and under clear jurisdiction of technocrats and technical experts in the field. However, the actors involved in the standardisation process was wide-ranging and across geographical boundaries. The complex nature of the standardisation was reflected in the frequent changes in principal actors and central locales throughout the two decade long controversy. Moreover, the standardisation process has been shaped not only by the narrowly defined technical factor but also by intrinsically social factors. It was found that the context of standardisation, a configuration of various sociotechnical factors, affected the criteria of technological properties of artefacts, interests relations formed around them, and alliances with other actors. This raised a difficult challenge for the organisation and analysis of research, and called for a conceptual framework capable of dealing with such complexity. The concept of 'development arena' (Jørgensen & Sørensen 1999) was chosen, for its decentralised concept of actor and flexible arena concept effectively help to map out the changing configurations of the Korean character set standardisation process. This section briefly looks into the complex nature of the Korean controversy and attempts to summarise the whole Korean controversy as an evolution of Korean character set standardisation arena using the concept of 'development arena'.

First, a variety of actors at various levels and in different locales were involved. The controversy, first of all, has been shaped by the interactions of a variety of actors in Korea. The Korean government had been a major initiator and co-ordinator of the national standard-setting process by the activities of standards bureau, research institutes, and executive branches. Expert activists played important parts in the standardisation process through their membership in expert advisory committees,[41] civic campaign groups, or professional associations. The manufacturers and independent retailers of computers, and software developers were all important participants in the standardisation process. Personal computer user-groups and the public in general became closely

[41] Ad-hoc Expert Advisory Committee was set up for KSC 5601:1987, and more formalised Korean Experts Committee, Korean JTC1 SC2 and SC/WG2 were formed in mid-1991.

involved in the controversy too. Also, the range of actors influencing the Korean character set standard development was not limited to the national boundary. International standards developers such as ISO, IEC, and ECMA had shaped the structure of international character set standards, both enabling and constraining the Korean standardisation process. Leading multinational companies in computer hardware and software had set the personal computer architectures,[42] or directly participated in international standards-setting process through increasingly popular standards consortia. Standards policies of foreign governments also had effects on the Korean standardisation by their participation in the international standardisation organisations and the implementation of their national standards.[43]

Second, the Korean controversy shows that the interactions between actors have been played against a backdrop of certain historical configurations, and the relationships formed between the actors have changed, as the configuration of standardisation arena, that is, the immediate and broader environments of standardisation, transformed over time. Within the locale of Korea, the legacy of a strong state during a series of authoritarian governments[44] formed the basis of virtual government monopoly over the character set standardisation process in the 1970s and 1980s. When the circumstances changed, however, with the political democratisation and the growth of civil society, the national character set standardisation process was opened for a broader participation from the early

[42]The Korean controversy began with the emergence of two rival 2-byte fixed length character sets, Wansung and Johap. The success of these character sets over the previous N-byte and 3-bytes ones was largely indebted to the market domination of 16-bit IBM PC architecture (Lee & Jung 1991).

[43]In particular, the successful implementation of the first double-byte national standard, Japanese JIS C 6226, had strong influence on the formation of the KIS C 5601:1987 (Lunde 1999, p.71).

[44]See, Hyug-Baeg Im (1987) The Rise of Bureaucratic Authoritarianism in South Korea, and Su-Hoon Lee (1993) Transitional Politics of Korea, 1987-1992: Activation of Civil Society, for the formation and transformation of authoritarian regime in Korea.

1990s.[45] Also, the relation between the local and global has changed during the course of the Korean controversy. At its early stage of industrialisation, Korea had no technological basis in the information technology and made no contribution to the formation of international character set standards, ISO 646 and ISO 2022, which, on the other hand, unilaterally constrained the Korean character set standards formation. However, from the late 1980s, when the developers of UCS and Unicode began to shape the third generation international character set standards, Korean standardisation constituencies became actively involved in negotiating the structure and Korean repertoire of the emerging international standards. While the trend in international character set standards arena still set the tone for the Korean national standard development, both the direct participation of Korean delegates in the international standard-setting bodies[46] and the results of the local standardisation process has had impacts on the construction of UCS and Unicode directly or indirectly, suggesting a significant shift from a unidirectional relationship between the local and the global to that of mutual shaping in the character set standard-setting process.

Those features of Korean controversy, the involvement of multiple actors and the transformation of relationship between actors as well as the context of standardisation process, draw attention to the two potential source of weakness in main conceptual frameworks employed to analyse the shaping of technological standards. First, the Korean controversy shows that the centrality of any actor can not be assumed. Throughout the Korean character set standardisation process, a number of actors at different levels and in various locales have involved in the standardisation process directly and indirectly. Even though some actors

[45]Apart from setting up the Korean JTC1 SC2/WG2 (Industrial Advancement Administration 1991*a*), the government introduced National Science and Technology Advisory Council in May 1991 in order to broaden the knowledge base of the policy (Science & Technology Policy Institute 1997, pp.367-369).

[46]Korea regularly sent delegations in JTC1 SC2/WG2 meeting, and Haansoft Ltd. bought member of Unicode consortium in 1995 and cast all the important ballot for Korean repertoire change in Unicode 2.0 which was passed with the majority of one vote. See for more, the section 7.4.

successfully built powerful networks along their interests and dictated the standardisation process for a period of time, the centrality of the standardisation has moved from one group of actors to others and from one locale to another. Adequate understanding of the standardisation process requires a decentralised concept of actor, employing a 'multi-actor and often multi-level scope' (Russell & Williams 2002, p.77). Second, it also demonstrates that the fixity of meanings given to a technological artefact and the interests embedded in it can not be taken for granted, as the meanings and the interests relations are dependent on the immediate and broader contexts as well as the efficacy of the network building activities. The case suggests that the meanings attributed to artefacts and the alliances formed around the conceived interests had been, to a varying extent, shaped by the contingent historical configurations of standardisation contexts, that is, the mixture of social, economic, political, cultural, and technological factors surrounding the standardisation process. Thus, the case requires an anti-essentialist position on interests relations (Sørensen 2002, p.21), and, at the same time, called for a historical perspective in order to integrate crucial but slow changing factors (MacKenzie 1990, pp.7-8), in particular, structural factors which formed the background to the standardisation activities of each stage.

The findings of the case study, therefore, appears fit to a trend of social shaping approach emphasising the need for a decentralised concept of actors and attention to the transforming terrain of environment over time. The concept of 'development arena' proves particularly helpful to reconstruct and understand the overall process of Korean character set standardisation. Jørgensen & Sørensen (1999) defines the concept as;

> In our definition a development arena is:
>
> A cognitive space that holds together the settings and relations that comprise the context for product or process development that includes:[47]

[47] Slightly different wording in Jørgensen & Sørensen (2002, p.198), 'A development arena, in our definition, is characterised and delimited by a space that holds together the settings and relations that comprise the context for product or process development that includes:⋯⋯'

- A number of elements such as actors, artefacts, and standards that populate the arena,
- A variety of locations for action, knowledge and visions that define the changes of this space, and
- A set of translations that has shaped and played out the stabilisation and destabilisation of relations and artefacts.

……

> As describe above, a 'development arena' is a metaphor for the cognitive space where political, social and technical performances related to a specific technological problem takes place. It is a spatial imagery that brings together heterogeneous elements that seem distant in geographical and conventional cultural space (Jørgensen & Sørensen 1999, pp.410-411).

Using the concept of 'development arena,' a variety of heterogeneous elements related to the Korean character set standards setting process are brought together in a cognitive space of Korean character set standardisation arena. Central actors and locations are identified across different level of actors and geographical boundaries, according to the impacts they have on the Korean character set standards at a given time. The changes in immediate and broader settings around the standardisation process is conceptualised as periodic shifts in the configuration of heterogeneous elements constituting the Korean character set standardisation arena. The arena itself is seen to have experienced a series of historical configurations, each of which exhibit certain degree of stability in major elements, such as, central actors, major location, character set standards, technological environment, socio-political situation, nature of relationship between actors, and the meanings attached to and interests identified with artefacts, producing a distinctive modes of performance.

In chapter 6, 7, 8, the description of Korean character set standards setting process was focused on the three central stages: the two separate periods of local controversies in Korea and a period of cooperation during the transformation of international standards regime in-between. However, the nature of Korean character set standardisation, to a large extent, had been prefigured by the early development of character set standards abroad from the 1950s onwards, and thus, the conceptual boundary of Korean character set standard arena expands into the past. With the expansion in minds, the Korean character set standardisation arena seems to have evolved through six distinctive configurations. The transformation of the arena as a whole with main features of each configurations are summarised in Figure 9.1.

The first configuration

The Korean character set standardisation arena is, in an important sense, prefigured by an event in a remote location, the creation of the first national character set standard in U.S. In the 1960s, U.S. computer industry began to realise the need for a standardised character set at national level, and ASA (American Standards Association) developed the ASCII (American Standard Code for Information Interchange), a 7-bit character set standard, in 1963. The main argument for the 7-bit structure was that the 7-bit structure was a technologically more reliable and economically more viable solution compared with the proposals based on 6-bit and 8-bit respectively (C.E. MacKenzie 1980). However, the technological and economical considerations were all based on a cultural factor, the 24 Latin-based English characters, and this seemingly natural cultural assumption became a source of problem later.

The second configuration

The arena had evolved into the second configuration with the formation of international character set standards. The early development of ASCII became an integral part of Korean character set standardisation when it was successfully internationalised by prominent international standardisation organisations, such as, ECMA (European Computer Manufacturers Association), and ISO (International Standardisation Organisation). Reflecting the dominance of the U.S. computer

1st configuration: U.S. (1960s)

Actors:	ASA, American computer industry
Factors:	Growing need for national standards in U.S.
CCS:	ASCII

2nd configuration: ISO, ECMA (1960s-1970s)

Actors:	ISO, ECMA, JIS
Factors:	Internationalisation of ISO 646, and development of ISO 2022
CCS:	ISO 646, ISO 2022, JISC 6226:1978

3rd configuration: Korea (1967-1987)

Actors:	Domestic computer industry, foreign manufacturers and software developers
Factors:	Diffusion of computer technology, 16-bit IBM PC architecture
Events:	Experiments on Korean character encoding and chaotic competition
CCS:	N-byte, three-byte code, double-byte codes, KSC 5601:1974, KSC5601:1982

4th configuration: Korea (1987-1992)

Actors:	Standard bureau, MIC, Industry experts, Civic campaign groups
Factors:	Government initiatives, democratisation, social movement
Events:	The first round of Korean controversy
CCS:	Wansung and Johap

5th configuration: ISO/IEC JTC1, Uniocde consortium (1992-1995)

Actors:	JTC1,Unicode consortium, Korean JTC1, Haansoft
Factors:	Internationalisation of software, Emerging new Interantional CCS Standards
Events:	Cooperation among the former adversaires for Korean repertoire increase
CCS:	Inclusion of all 11172 Modern Hangul Syllable and 240 Jamo in Unicode

6th configuration: Korea (1995-2000)

Actors:	MS, Haansoft, Government, Industry experts, Civic groups, Users communities
Factors:	Success of WWW, Internationalisation of software, Integrated Windows environment
Events:	The second round of Korean controversy and closure
CCS:	Survival of Johap until final convergence on Unicode in 2000

Figure 9.1: Summary of six configurations of Korean CCS standardisation arena.

industry in the world computer market and the common use of Latin-based scripts in Western European countries, ECMA accepted the structure of ASCII and published ECMA-6 (7-bit input/output code) in 1965 with minor modifications of code points. ISO finalised the internationalisation of ASCII with the

Recommendation 646 in 1967 which includes the IRV (International Reference Version) and twelve positions for national variants.[48] Soon, however, the limitation of 7-bit ISO 646 with only 94 code points for printable characters became problematic, as the computerised information processing spread beyond U.S. and Western Europe, requiring the inclusion of non Latin-based phonetic scripts and the large number of ideographs. ISO devised the ISO 2022, which defined the rules for 8-bit and double-byte extension techniques for countries with larger character repertoires. ISO 2022 was a crucial contribution for a more inclusive international standards regime. However, the major consideration of the extension techniques was its compatibility with the existing 7-bit code structure, and for this reason, ISO 2022 was built around ASCII and ISO 646, which seriously compromised the capacity of extension from its potential 65,536 code points to a mere 8,836.[49]

The third configuration

The third configuration of the arena was characterised by the early Korean experiments on character encoding from the 1970s and the emergence of two major market standards towards the mid-1980s. Unsupported by the original specifications of imported computers, Korean engineers devised and experimented with various Input/Output systems to incorporate Korean indigenous script, Hangul, and Chinese ideographs used in Korea, Hanja, in computing environment. During the 1970s and 1980s, domestic computer industry was growing fast, and the major players in Korean computer industry preferred proprietary character sets of their own. Amid this chaotic competition among character sets, the government initiatives to set national standards had failed twice in 1974 and 1982. A variety of N-byte, three-byte, and double-byte character sets were developed and tested in the market. However, as the personal computer became more important part of corporate and personal information processing and its architecture

[48]See for more, the section 4.2.

[49]See section 4.3. and 9.1 for the structure of the ISO 2002 extension techniques and the social choice involved in the design decision.

was standardised on the 16-bit IBM PC in the mid-1980s, the competition for a de facto Korean character set standard was reduced to the two rival double-byte character set standards, Johap and Wansung.

The fourth configuration

The fourth configuration of the Korean character set standardisation arena was characterised by the strong government initiatives for a 'de jure' national standard, and the subsequent public controversies over the contents of the national standards between 1985 and 1992. Government standard bureau, advisory committee, departments, industry, civic campaign groups all involved in an increasingly intense struggle to steer the design of the national standards in their favour. During the first half of the period, government successfully technicised the standardisation process, confining the debate within the narrowly defined technological matter. The government experts dominated the technological authority, and passed the KSC 5601:1987 despites the objections from industry. However, as the experts from industry and academia challenged the authority of government experts, the political nature of the technological standards became apparent. Soon, the disputes among experts became escalated into a full-scale public controversy. In 1992, the successful mobilisation of pro-Johap camp managed to force the government to acknowledge the market 'de facto' standard, Johap, as a part of the dual national standards system, KSC 5601:1992. Throughout the first Korean controversy between 1987 and 1992, the power balance between the state and civil society had been an important factor shaping the outcomes of the national character set standardisation. The legacy of strong state and its initiatives in technology policy had led to the first successful national standardisation in 1987, but the political democratisation of Korea in the late 1980s and the following invigoration of civil society and social movements set the tone for the subsequent development of the Korean character set standardisation.

The fifth configuration

The fifth configuration of the arena was characterised by the change in focus back into the international standards setting process and the active participation of Korean standardisation constituency in the new international standards development. Internationalisation of the software market and the dominance of a few multinational software houses formed the background of the emergence of new multilingual character sets standards in the form of UCS and Unicode. Korean participation in the third generation international standards was organised through the newly established broad-based expert committee, Korean JTC1/SC2/WG2, under which the experts from industry and academia were brought together for the first time in a permanent government institution. Even though the committee consists of the mixture of former adversaries from the first phase of Korean controversy, the committee soon developed an unprecedented cooperative working relationship and made significant contributions to the enlargement and reshuffle of the Korean repertoire in UCS project. The cooperation facilitated the collaboration between the Haansoft and Microsoft Korea - the most fiercest rivals in the Korean word-processor market - in the Unicode technical committee over the issue of Korean repertoire enlargement.

The sixth configuration

The sixth configuration of the arena was centred on Korean local controversies again and characterised by the continued contest between the two dual national standards, the return of public controversies in 1995 and 1998, and the closure of the controversy itself in 2000. Having a keen interest in the internationalisation of software, Microsoft committed itself to the development and implementation of Unicode. As Unicode became more viable option for Korean character encoding with the complete repertoire of 11,172 Hangul syllables, Microsoft Korea U-turned from its public endorsement of Johap for the forthcoming Windows

95 Korean version, and opted for a proprietary character set as an interim solution between the existing Wansung standard and future implementation of Unicode. However, the adoption of proprietary standard was strongly resisted by most of Korean standardisation constituency, and Microsoft Korea was forced to yield to the mounting pressure from government, expert community and the public. Another major controversy erupted in 1998, when Microsoft attempted to kill off HWP, the most popular Korean word-processor applications, with a conditional investment offer to its financially troubled developer, Haansoft Ltd. An unprecedented public outcry ensued, and a campaign against the deal successfully raised finance to take over Haansoft in order to safeguard HWP from Microsoft's threat. HWP was virtually the only mainstream program using the Johap character set, and the survival of the HWP seemed to secure the future of Johap. However, HWP lost its competitive edge against other Unicode-enabled word-processors, as the Unicode was adopted in Windows environment with the full Korean Hangul syllable repertoire. In 2000, faced with mounting costs to maintain the proprietary Johap-based Input/Output libraries, Haansoft decided to abandon Johap as its basic character set, effectively ending the competition for 'de facto' Korean national character set standard.

9.5 Conclusion

This chapter examines four key analytical themes emerging from the case study. The first theme is the contrast between the enduring presence of technological determinism and the social choices embedded in technological artefacts. Section 9.1 identifies a common but misleading perspective on the character set standardisation as 'technological fix on a cultural problem.' From the perspective, the problem in Korean character encoding was caused by a temporal gap between the developmental stage of information technology on one hand, and the local requirements for large codespace based on the cultural idiosyncrasy of Korean writing system. The cultural problems, or culturally induced technical problems, the initial difficulties and subsequent controversies in Korean character encoding, is seen to be resolved by the predictable and inevitable technological improvements - higher processing power, cheaper memory and communications lines - which allowed more resource allocated to character encoding. However, the case study shows that the size of 'codespace' - which was perceived by many as the most important technologically driven factor - has not been entirely determined by the amount of resource used but also, in large part, by the different usage or allocation of the given codespace, which reflects competing priorities and interests of the parties involved in the design and implementation of character set standards.

The second theme is the two conflicting modes of standardisation found in the Korean character set standardisation process, that is, technicisation and politicisation. Section 9.2 seeks to explain how the arcane world of technological standards became a subject of public controversy in Korea from the late 1980s onwards in relation to the two competing logics of standardisation. After two decades of chaotic competition among many proprietary standards, the Korean government and standard bureau successfully technicised the character set standardisation, where objective technical grounds were assumed to be the only legitimate criteria for character set standard-setting. While the new discourse was instrumental in successfully establishing the national standard for the first time, soon the authority and assumed objectivity of the new paradigm was challenged by a series of publicised disagreements among different expert groups over the crucial properties of the two competing standards. During the escalation of disputes, the standards bureau's authority in adjudicating the technological properties of given character sets was contested and undermined by counter-arguments endorsed by experts from industry and academia. This weakened the technicised mode of standardisation and contributed to a shift back to the politicised mode of standardisation in which the social basis of technological knowledge is widely recognised and strategic alliances of interests were actively pursued in order to promote specific standards.

The third theme is the dynamic artefacts-interests relationship and unstable interests alliances around the evolving character set standards. The case study shows that the actors' identification of their interests vis-à-vis a given artefact has been changing as a result of network building activities of actors and the changes of circumstances surrounding standardisation process. As was shown in chapter 6, the Korean controversy began with a competition between two overriding concerns regarding the national character set - free expression of national language and international compatibility. Along this fault line, two opposing alliances were formed in order to shape the design of a national standard in their favour. However, the interests alliance was soon destabilised and transformed into another, as the immediate and broader environments of standards changed. The alliances of interests had transformed repeatedly through the two decades of Korean national standardisation controversy, forming five instances of distinctive interests alignments.

The fourth theme emerging from the case study is the complexity of the Korean character set standardisation and the usefulness of 'development arena' concept to understand the rich and multifaceted standard setting process. First, the case shows that a number of actors at different levels and in different locales have involved in the standardisation process with frequent changes in terms of central actor, location, and the predominant relations between them. The decentralised concept of actors in arena framework helps to identify and follow the activities and strategies of actors assuming central role at various stages of the Korean character set standardisation. Second, the evolution of the Korean character set also shows that the transformation of the immediate and broader environment had important bearings on the meanings and interests ascribed to standards and the alliances formed around them. The concept of development arena offers a useful framework to integrate those changes around the standardisation process by conceptualising the Korean character set standardisation arena undergoing a series of historical configuration of heterogeneous elements including social, economical, cultural, and political factors as well as technical ones.

CHAPTER 10

Conclusion

This thesis examined the historical array of 'social' and 'technical' factors that have shaped the development and evolution of Korean national character set standards. Character set standards refer to a group of compatibility standards at the most basic level of Information and Communication Technologies (ICTs), specifying rules for digital representation of textual data. The effective and efficient operation of information processing, storage, and exchange is dependent on the existence of technically, economically, and culturally adequate character set standards at national, regional and international levels. Historically, the earliest national and international CCS standards had emerged around the cultural presumptions and practices of the US and Western Europe due to the economic and technical dominance of the region from the formative stage of ICTs development. Since then, the need for global information infrastructure and multilingual information processing has been growing, and the international CCS standards regime has evolved (from ISO 646, to ISO 2022, and ISO/IEC 10646-1) to incorporate various national scripts around the world. However, issues have arisen over the representation of non Latin-based scripts and the exchange of data from multiple character sets. For example, the incorporation of East Asian scripts, such as Chinese, Japanese, and Korean, presents a formidable challenge with their exceptionally large repertoire. In particular, the Korean case is unique and interesting in that the design and implementation of Korean national CCS standards - normally a domain of exclusive group of ICTs experts - has evolved with a series of heated public controversies during the 1980s and 1990s.

Despite the huge economic and policy interests surrounding the ICTs and its standardisation in general, the standardisation of character sets has not been subject to detailed socio-economic analysis, a result of which is that the discussion over the topic has been dominated by deterministic or simplistic speculations that economic imperatives, technological rationalities, or corporate strategies alone have guided the evolution of character set standards along a linear development path where increasingly larger and more powerful character set standards has replaced previous versions. Drawing on the social shaping of technology perspective, this thesis examines a series of controversies surrounding the Korean national character set standards setting in the 1980s and the 1990s that accompanied the evolution of the international character set standards regime (from ISO 646, to ISO 2022, and Unicode). The primary research objective is to produce a detailed empirical account of the standardisation process and to engage in an analysis on the emerging themes. The research, as a whole, produced a non-deterministic, anti-essentialist, and dynamic account of the social shaping process. This concluding chapter summarises main findings by answering the research questions set out in the introduction, and then assesses overall implications of the research.

10.1 Research Questions

The general ideas behind the questions had emerged from the preliminary research on the subject and has guided the research process throughout as well as the questions were developed and refined through the research process. The four research questions are as follows:

- To what extent can the development of Korean and international character set standards be explained in terms of technological advances and social choices?

- What were the circumstances leading to the successful technicisation and also to the politicisation of the standardisation process in the Korean national character set standards controversy?
- What were the main factors behind the recurrent stabilisation and destabilisation of the standards and the interest alliances behind them?
- What was the nature of the relationship between local and global constituents of the character set standard setting process, and how has it changed through the period of the Korean controversy?

The research questions were mainly empirical in nature, but they are also related to more analytical themes developed during the investigation. This section revisits the four research questions and the related theme in turn.

- To what extent can the development of Korean and international character set standards be explained in terms of technological advances and social choices?

The first research question leads us to confront a form of technological determinism found among many participants and observers of the Korean coded character set standards development. The whole standardisation process was commonly seen as a 'technological fix on a cultural problem', for the initial codespace shortage under ISO 2022 and its later enlargement in UCS and Unicode were perceived as the most crucial factors determining the course of local controversy. However, the case study refutes the deterministic interpretation by showing the complex and unpredictable nature of the standardisation process. In particular, it shows that both the size of codespace in the international standards and the contrasting Korean character set designs (Johap and Wansung) were intimately shaped by certain social choices based on the conflicting concerns and priorities of various actors involved in the design and use of the standards. First, ISO 2022 extension techniques were built around the 7-bit ASCII to minimise the disruption to existing systems, mainly in U.S.A., with the consequence of loss of more than 85 per cent of codespace for double-byte extension. Second, the design features of Johap and Wansung also clearly reflect a social choice between two social interests over the national standards. In both cases, the state of technological development certainly set a limit on the range of solutions available, but equally important were the choices made in the technological designs of those character sets, which reflect the conflicting interests of various groups of actors and the unequal power and resources to realise those interests.

- What were the circumstances leading to the successful technicisation and also to the politicisation of the standardisation process in the Korean national character set standards controversy?

The second research question deals with the circumstances of a rare occasion of public controversy on technological standards, and two distinctive modes of standardisation found in the Korean character set standardisation process, 'technicisation' and 'politicisation'. The technicised mode of standardisation promotes an image of standardisation as a purely technical process in which superior technological design is chosen on the basis of technical merit alone. Under this mode, the discourse over standardisation appears to take place in a space divorced from social, and economic interests. The standardisation process remains uninteresting or arcane to the public. On the other hand, the politicisation is the process in which actors identify particular interests embedded in the technological standards and seek to promote their own interests by supporting the 'right' standards with various standard strategies. The early stage of Korean character set standardisation until the mid-1980s had been characterised by strategic manoeuvres of private interests. Then, after two attempts to arbitrate the interests had failed, government took the initiative and successfully technicised the standardisation process and set up KSC5601:1987 with the help of the authority of technological expertise from the standard bureau and the advisory committee, which endorsed the new national standard as a technologically superior solution.

Later, however, the technicised world of character set standardisation was undermined by the increasing criticisms by experts from industry and academia who had been excluded from the government-led standardisation process in 1987. The critics challenged the legitimacy of KSC 5601: 1987 both on technological grounds as well as its cultural and social implications, and by doing so, they publicly questioned the credibility of the official version of technological knowledge. The challenge successfully weakened the image of the new national standard, KSC 5601:1987 as the best solution based on purely technical grounds, and the disputes on the issue began to gain publicity so far denied. Since the authority of the experts in the government standard bureau and advisory committee was essential for the technicisation of standardisation, the attribution of incongruent technological properties by different experts to the same technological artefacts helped to weaken the image of technological knowledge as 'hard facts' (MacKenzie 1990, pp.9-10), and helped to bring the issue of interests to the fore, leading to the politicisation of the standardisation.

The politicisation of Korean character standardisation also involves the active alignment of individuals and organisations with similar interests and concerns, as well as the identification of the political nature of the technological design. The two overriding concerns regarding the national character set were the free expression of the national language in the computing environment and the international compatibility of the Korean input/output systems. Along this fault line, two opposing alliances were formed in order to steer the design of character set standards in their favour. Core supporters for each competing character set, Johap and Wansung, tried to enrol other social groups as allies by translating their various cultural, economic, and political interests in relation to the main goals of each camp regarding the standardisation issue. The design of character set standards became a subject of political mobilisation by the interested parties alongside the diminishing possibility of resolution by 'objective' technological rationality.

- What were the main factors behind the recurrent stabilisation and destabilisation of the standards and the interest alliances behind them?

With the politicisation of the standardisation from the late 1980s, the Korean character set standardisation has been characterised by competing interest-alignments and network building strategies, for which the actors' identification of their interests with certain technological properties of a standard has been crucial. However, an interesting pattern of development in the Korean character set standards controversy over time is the recurrent stabilisation and destabilisation of the interest alliances and its effects on the standardisation process. The case study shows that as the circumstances surrounding the character set changed, actors' interests vis-à-vis given character sets and also their positions towards the existing coalitions were transformed. This draws our attention to the dynamic nature of interest coalitions and the unstable relationships between interests and artefacts.

From the emergence of first competing coalitions around 1987, there have been five instances of different interest alignments dictating the course of Korean national character set standardisation process. The first interests alliance emerged with the re-politicisation of the character set standard issues from the late 1980s and consolidated during 1990-1991 when the first amendment of KSC 5601:1987 became a focus of controversy between the pro-Johap and pro-Wansung camps. The second alignment of interests was characterised by the strengthening of the pro-Johap camp with the activities of two civic campaign groups and the defection of the Ministry of Culture from the pro-Wansung camp, which successfully persuaded the government to accept the market standard Johap as a part of dual national standards system. The third interest alignment was the unprecedented cooperation among the former domestic adversaries and their concerted effort to incorporate Korean script in UCS and Unicode from early 1992 to 1995. The experts from opposing camps cooperated within the newly formed Korean JTC1/SC2/WG2 from early 1992. Then, even Microsoft and Haansoft, the two archrivals in the word-processor market, worked together in order to ensure there would be a viable Korean script support in UCS and Unicode. Then, under the fourth interest alignment, most of the Korean actors united against the Microsoft's attempt to switch to its proprietary Korean character set in 1995 and against the Microsoft's bid to Haansoft to force out HWP, its main rival word-processor in 1998. Finally, the fifth alignment was the dissolution of the Johap alliance and closure of the controversy itself. Haansoft, the developer of HWP, decided to abandon Johap in favour of Unicode for new range of word-processor development in 2000, and this effectively ended the Korean national character set standards controversy.

What appears to be the case is that the transformation of the interest alliance has been based on the actors' reflexive assessment of the changing environment affecting the perceived technological properties of and prospective interests served by the given character set standards. For example, the defection of the Ministry of Culture was strongly influenced by its desire to develop computerised language related research projects as it took over language policy from the Ministry of Education. The existing national standard became an obstacle for this project, because of its limited support for Hangul syllables. The government's shift from an exclusive to an inclusive standards policy and the unprecedented co-operation among former adversaries were closely related to the changing prospect of the new international standards and the opportunities they opened up for local actors to shape the direction of the new international standards according to their local needs. Microsoft's deviance in 1995 from the existing national standard reflected the transition of the international standard regime from ISO 2022 to Unicode, and the altered meaning of the national standard KSC 5601:1987 from a convenient tool for entering a local market to a cumbersome burden for the company's new strategy of internalisation of software. Finally, Haansoft's decision to abandon Johap in 2000 ultimately showed that the relationship between an actor and an artefact was contingent and circumstantial.

Unicode's growing dominance in the system software market and the complexity of Windows APIs finally transformed the meaning attached to Johap from 'a uniquely powerful Korean character set standard' to an 'inconvenient and costly character set standard'. Rather than the interests of actors embodied in the artefacts remaining constant (Schmidt & Werle, 1992), it showed the dynamic nature of the relationship. The case suggests a need to reconsider the relationship between interests and artefacts in early social shaping studies, and contributes to a more intricate analysis of the settings and processes of social shaping.

- What was the nature of the relationship between local and global constituents of the character set standard setting process, and how has it changed through the period of the Korean controversy?

The fourth research question addresses the changing relationship between actors and especially between the local and global ones. One prominent feature of the Korean controversy was that the standardisation process involved multiple actors in different locales and that the relationship between them changed with the transformation of its context over time. First of all, the controversy has been shaped by the interactions of a variety of actors. Within the locale of Korea, government has been a major actor in the field from early on through the activities of executive departments, standards bureaus, and research institutes. Experts in industry and academia engaged in the standardisation process by their membership of expert advisory committees[1] or through the activities of civic campaign groups or professional associations; manufacturers and independent retailers of computers, and software developers were also important participants in the standardisation process. Personal computer user-groups and the public in general became closely involved in the controversy too. In addition, actors

[1] An Ad-hoc Expert Advisory Committee was set up for KSC 5601:1987, and more formalised Korean Experts Committee, Korean JTC1 SC2 and SC/WG2 were formed in mid-1991.

abroad have involved in the standardisation process in various ways. International standards developers such as ISO, IEC, and ECMA had steered the structure of the international standards with both enabling and constraining effects on Korean character set design; leading multinational computer manufacturers and software developers have shaped personal computer architectures with a specific input/output environment, and have been directly involved in international standards-setting through consortia and formal standards-development organisations; standards policies of foreign governments also had a certain influence on the Korean standardisation by their participation in the international standardisation process and implementation of their national standards, providing exemplars for other countries.

Second, the interactions between the actors have been formed against the backdrop of certain historical configurations. Moreover, the relationships between the actors either within a locale or across locales have changed as the broader contexts transformed. Within the locale of Korea, the legacy of a strong state during a series of authoritarian governments in Korea formed the basis of the virtual government monopoly over character set standardisation in the 1970s and 1980s. When the circumstances changed, however, with political democratisation and its diffusion into other realms of Korean society, the process of national character set standardisation was opened up to broader participation from the early 1990s. Another important dimension of change is the relation between the local and global. With virtually no computer industry until the 1970s, Korea had made no contribution to the formation of international character set standards ISO 646 and ISO 2022, even though these unilaterally constrained the Korean character set standards formation. ASCII itself was a local standard optimised to the cultural needs of the U.S.A., but it later became a global standard due to the predominant economic and technological power of the U.S.A, shaping the grounds for the subsequent local controversy in Korea. In the early 1990s, however, as ISO/IEC JTC1 and Unicode consortium sought a truly multilingual international character set standard, Korean actors became actively involved in negotiating the structure and repertoire of the both standards. Still the new trend in international standards set the stage for the Korean national standard setting, but both the direct participation of Korean delegations in the international standard-setting bodies and the legacy of the local controversy also influenced the design of UCS and Unicode, indicating a shift from a unilateral to mutual shaping of the local and the global in the character set standard-setting process. Therefore, the case study seems to indicate that what constitutes the local and global or the nature of relationship between them is dependant on its place in a given historical configuration of the heterogeneous elements.

10.2 Implications of the case study for theory

Apart from answering those more empirically oriented questions, the case study sheds interesting insights on our understanding of ICTs standards setting processes and theoretical discussions in the social studies of technology in general. As the case study reveals a structured, but complex and unpredictable social shaping process, it opened up a new research site for social shaping research, and provided insights into the relationship between artefacts and interests, and also demonstrated a need and value of multi-level approach in order to capture the complex and dynamic process of social shaping.

First, the case study is the first attempt to conduct a socio-technical study in the area of character set standardisation process. Being a basic medium of essential, but mundane, routine, and day-to-day functioning of the ICTs system, the design and implementation of character set standards had rarely attracted attention from outside of technological communities in the field. Even when the character set standardisation became a public issue among competing social groups, as in the case of Korean controversy, most conventional accounts had been dominated by various deterministic and simplistic perspectives, such as technocratic, economic, or simplistic socio-political approaches. The empirical study into the Korean character set standardisation provides a strong antithesis to those widespread deterministic and simplistic perspectives by showing a complex case of social shaping with technological, economic, political, social, and cultural factors involved. By opening up the black box of a character set standards for socio-economic analysis, the case study thus widened the research front covered by the social shaping of technology perspective and added an additional empirical case study in their tradition.

Second, the case study provides important new insights into the relationship between artefacts and interests. Since the social shaping approach drew attention to the interests embedded in technological artefacts (Noble 1979, Pinch & Bijker 1984, MacKenzie & Wajcman 1985), the relationship between the two had become a source of methodological, epistemological and ontological disputes in the social studies of technology(Williams & Edge 1996). In particular, there have been disagreements over the carrier of interest, reflecting the broader macro-micro debate in social science in general (Pinch & Bijker 1986, Russell 1986, Russell & Williams 1988, Russell 1991). The initial account of the Korean character set standardisation looked rather similar to a mixture of early social shaping accounts in that the contents of technological artefacts have been shaped by both strategic activities of actors and broader contexts of the technology.[2] However the extension of this case study over time and across a number of locales has demonstrated the need and possibility for a more intricate analysis, which implies an anti-essentialist and flexible relationship between artefacts and interests.

The case study, most of all, confirms the centrality of the interests concept in understanding the technological change. shows that the actors' attribution of certain technological properties to a given character set is dependent on their divergent interests towards the technological artefacts, which is, in turn, shaped by their different priorities and concerns as to the use of computer system. This

[2]The contribution of the Labour process theorists on the suppression of record playback in favour of numerical control machine tools(?) and the study of SCOT over the closure in bicycle design(Pinch & Bijker 1984) are good examples of contrasting approaches

may well be influenced by idiosyncrasy of actors, but more evidently by broader contexts in which individual and institutional actors finds themselves in, such as, professional interests, changes in political culture, cultural heritage, Korea's relative position in world information technology market. The actors' identification of interests vis-à-vis a specific character set, on the other hand, is the very basis of the network building activities of competing groups of actors trying to shape the standardisation in their favour. Through two decades of controversy, a series of standards have been designed, sustained, criticised, abandoned, or replaced largely according to the relative success of network building behind the character set in question. At the same time, the case study also shows the flexible and unstable nature of the relationship between the artefact and interest. The meanings attached to and the interests identified with a given character set were not fixed, but constantly transformed by, and dependent upon the changing configuration of standardisation arena, a combination of actors, technologies, and immediate and wider contexts, suggesting that even though specific interests are embedded in the technological artefacts, the relationship between the two are not static but dynamic. Throughout the Korean controversy, the Korean national character set standardisation arena had experienced six distinctive configurations and its changes had direct and indirect impacts on the interests relationship between the standards and actors, interests alliances formed around standards, and standards promoted and accepted by government, standards development organisations, and market.

Third, the case study implies a multi-level approach by combining the strengths of both micro and macro level approaches. The social shaping of technology as a theoretical framework has experienced an ongoing internal tension over the issue of the appropriate unit of analysis where a tradition of action-oriented research focuses more closely on the strategies and activities of actors, while the structure-oriented tradition emphasises the constraints generated by historical and structural factors. (Russell & Williams 1988, Williams & Edge 1996)

However, one important line of new developments in the social shaping approach in the last decade has revolved around various attempts to bridge the gap between these two traditions. Researchers from each tradition have begun to appreciate the usefulness of a multi-layered approach, and new concepts have been devised which, in different ways, have sought to tackle this tension and tried to incorporate more balanced approach (Sørensen 2002, Williams 2002). The concept of 'development arena (Jørgensen & Sørensen 2002)' has been particularly useful for this study, guiding attempts to organise conceptually and analyse the case, in which a variety of actors have been interacting each others in changing configurations of actors and structural environments across geographical locales and time. As discussed in the previous chapter, the case demonstrates that the design and implementation of character set standards has been strongly influenced both by the competing network building activities of the local actors in a given configuration of the standardisation arena on the one hand, and by the differently configured structural factors across changing arenas on the other. The case shows that at each stage of standardisation, the formations of interest alliances, the mobilisation of resources and enrollment of allies, were essential for determining the direction of standardisation process at each stage. However, the rationales and objectives behind network building - the meanings attached to and therefore the interests identified with given artefacts (standards and their champion applications, for example) - have been shaped by the immediate and broader context of a given arena. The arena concept here refers to a complex configuration: a collection of structural factors beyond the control of a particular local actor, such as, different cultural heritage and collective historical experiences, changing political culture of the locale, and globalisation of software market and information infrastructure. The concept of 'development arena' enables the research to follow the strategies and activities of local actors without losing sight of the constraining structural factors which are themselves shifting partly as a result of actors' network building and partly due to the historically contingent factors.

10.3 Reflections on research design and methodology

The research also provides an opportunity to reflect upon the research design and methodology - how they may have enabled and constrained the conduct and outcomes of the study. The research design, in general, has been informed by the research tradition of social shaping of technology approach which have an affinity with case study design.[3] The concept of 'strategic research site' informed the selection of Korean national character set standardisation process. As suggested in the quotation below, the Korean national standardisation provides the research project a microcosm in which to capture the key aspects of the character standardisation process within a manageable boundary of research.

> Clearly, part of the task of the emerging new field of technology studies is the identification of research sites at which the complexity of the seamless web is manageable but which at the same time serve to capture key aspects of technological development. We call such location strategic research sites(Bijker et al. 1987, p.191)

The research site was chosen for : first, the character set standardisation, even though it forms a basic level of ICTs compatibility standards, had not attracted attention from social studies of technology, second, the Korean national character set standards case, with its unusual escalation into public controversies, helps to identify and examine the conflicting concerns and interests involved in the standardisation process, third, the Korean national standardisation has developed in close connection with the changing international standard regimes, hinting the complex nature of local/global relationship.

One of the most important decisions concerning the research design was to extend the scope of the study, in particular, chronologically over a number of

[3]From the early stage of its development, the social shaping approach on technology has relied on detailed empirical case studies on the contents of technologies (MacKenzie & Wajcman 1985, Bijker et al. 1987, Elliott 1988).

stages of the Korean national standards development and spatially over the international and other national standards as long as they formed relevant contexts. During the course of research, it turned out that an adequate understanding of the Korean controversy requires an examination of the formations and transformations of interests alliances over two decades. Therefore, an investigation into the long-term development of the national character set standard setting process was favoured over the alternatives, for example, more focused analysis of a single controversy over short span of time, or a comparison between separate instances of parallel national standardisation processes in other countries. The introduction of historical dimension proved essential for the anti-essentialist understanding of the interest relations, and for the integration of slow changing structural factors.

However, the concentration on the long-term standardisation process in one locale inevitably left some of the potential research interests unexplored. Most of all, the expansion of the research beyond the Korean standardisation was limited to the parts of international standards or foreign national standards, which is directly related to the Korean standardisation. Some of foreign national standards and international standards mentioned in the research, such as, ASCII, JIS C6226:1978, GB 2312-80, ISO 2022 and ISO/IEC 10646-1 were not subjected to the socio-economic research on their own right. From the perspective of character set standardisation in general, therefore, a limited number of black boxes were opened to varying extents, leaving the remaining boxes for further studies. Further research into the shaping processes of the first and second generations international standards regimes would help to understand the working of the international standardisation arena which, in itself, went through dramatic changes over time and set the most important backgrounds of Korean controversy. Another intriguing research opportunity would have involved the expansion of the research into other parallel national standards setting processes. Studies on national standards setting process in region with similar cultural needs -

large repertoire of script - but different historical configurations, such as, China, Taiwan, and Japan, would be interesting targets of follow-ups.

10.4 Conclusion

This chapter returns to the research questions set out in the introduction and answers them as a way of summarising the findings from the case study, and addresses the overall implications of the case study in social studies of technology in general. The four main findings of the case study were discussed. First, the Korean character set standardisation process has shown a complex social shaping process against the conventional deterministic and simplistic perspectives. Second, the character set standardisation in Korea were subject to two conflicting modes of standardisation - technicisation and politicisation - both of which were results of active network building around the interests of actors involved. Third, the case has shown that, though the network building of shared interests was a central force in the standardisation process, it was subject to a series of radical transformations alongside changes in the configuration of the standardisation arena. Fourth, the case demonstrates a complex process involving multiple actors at various levels in different locales and the changing relationship between them. As a whole, the case study widened the research site of social shaping of technology approach, provided an insight into the dynamic relationship between the artefacts and interests, and demonstrated the merits of historical and a multi-level approach, combining the strengths of both the 'micro' and 'macro' approaches developed in the social studies of technology.

In summary, the case study reveals a structured, but complex and unpredictable social shaping process in which a variety of actors at various levels and in different geographical locales have been interacting to steer the standardisation process in their favour. An interest alliance is formed among actors with similar concerns, according to the specific configuration of economic, social, cultural, political and technological factors. However, as the immediate and wider environments around the character set standards changed, the alliances were unmade and replaced by or transformed into new ones, producing a series of character set standards. An analysis is thus advanced which addresses both periods of continuity in the configuration of actor-networks as well as periods in which alignments and the broader socio-technical arenas were reconfigured.

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